REPORT

to

The Honourable Ian Reid, Minister of Labour
Government of Alberta

from the

MALL COASTER INQUIRY

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REPORT

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NOTE

In the text of this REPORT:

(4326), a number in brackets, indicates the page number in the transcript of evidence; and

(Ex. 92), indicates the number of an Exhibit entered in evidence before the Board; and

(Ex. 56, p. 9), indicates the page number of an Exhibit being referred to; and

An insert in square brackets within a quotation is not part of that quotation, but is provided by the authors for the assistance of the reader only.

I. SUMMARY

A. WHAT HAPPENED

Three persons died and one person was seriously injured in a roller coaster accident which occurred between 9:30 and 10:00 P.M. on June 14th, 1986, in Fantasyland at West Edmonton Mall. The vertical axle on the left side of the rear car of the train lifted out of its housing with the result that the left bogie assembly of that car fell away. When this happened, the last car was no longer attached to the track and it fishtailed from side-to-side, striking steel support columns as it descended. The impacts of the last car against these columns released the lap bars and the four passengers fell from the train.

B. WHY IT HAPPENED

At its lower end, the vertical axle was secured in its housing by a keeper plate fastened with four high-strength cap screws. The four cap screws vibrated loose, and likely fell away from the critical connection, one at a time, in the hours or days immediately preceding the accident. The four relatively undamaged screws were found after the accident in widely separated locations on the floor of the coaster building.

These screws failed after the train had been in service for only 2,134 trips, which was approximately thirty days. The evidence before the Board has identified two principal deficiencies which resulted in the failure.

There was a manufacturing defect in the vertical axle assembly such that it did not conform with the specifications of its designer. The outside diameters of some vertical axles were machined too small. The consequent looseness in these vertical axle assemblies resulting from the manufacturing defect was one of the causes of vibration loosening of the four critical screws and the failure by fatigue of other similar cap screws.

There were also design defects in the vertical axle assembly. Certain of the engineering drawings used by the manufacturer to produce the vertical axle assemblies show a gap between the keeper plate and the vertical axle, and a keeper plate thickness that is not in agreement with the design calculations. The combination of these factors contributed to the vibration loosening of some cap screws and the failure by fatigue of other cap screws.

After the accident, cap screws from the keeper plates securing the vertical axles on various trains were examined and then removed for inspection and testing. Some of these screws had lost at least part of their preload, some were completely loose, and some of these screws had fractures caused by fatigue. Two screws were found to be completely severed and, of course, four screws had vibrated loose.

In a properly designed connection there should be no likelihood of vibration loosening or fatigue fractures during the design lifetime of the assembly. The loose screws and fatigue fractures found in other vertical axle assemblies after this brief operating period clearly indicates that a serious overall problem existed in each of the trains.

One other factor contributed to the accident in a less direct way. This is outlined in Part XI Maintenance, Section B(3).

C. OTHER MATTERS

There were other matters that arose during the course of the Board's investigation upon which the Board wishes to comment. These comments are contained throughout the Report.

The roller coaster travels at high speeds around sharp curves and this subjects the structure and the machinery to extreme, rapidly fluctuating stresses. The persons who assume the responsibilities of maintaining such machinery should exercise a particularly high standard of care in maintenance in order to protect the public who are invited to ride in it. The Board does not consider that the maintenance of the roller coaster in Fantasyland was up to such a standard, and it therefore has made recommendations in the section of this report dealing with maintenance.

D. HOW TO REDUCE THE RISK OF IT HAPPENING AGAIN

As in any area of human activity, it is impossible to reduce the level of risk on amusement rides to zero. All that can be done is to take all reasonable steps to reduce the risks. Such steps are primarily the responsibility of the owner and within his control. The owner can reduce the risk of accidents by:

- using well-designed, high quality equipment; and
- having a program of preventive maintenance that is of a high standard and anticipates hazards and attempts to reduce the risk of injuries to passengers on thrill rides; and
- training and supervising maintenance and operations personnel in safe operation and maintenance procedures; and
- using the services of outside, expert advice from time to time in order to provide an objective appraisal of all aspects of the operation.

Governmental inspection plays a very useful role in the public interest by monitoring what amusement devices are in operation, by requiring the provision of information about such devices, and by periodically inspecting and offering safety suggestions to owners. Government inspection is helpful, but it can make only an incremental contribution to safety.

The safety of an amusement device is ultimately the responsibility of the owner of that device who expects to profit from inviting the public to use it.

With respect to this roller coaster, from the evidence of the last two witnesses on the final day of the Public Hearings in the Fall of 1986, Mr. William Keur and Mr. Eskandar Ghermezian, it is clear that Triple Five acknowledges the existence of problems in the design and manufacturing areas. In the opinion of the Board, the design and manufacturing defects can be rectified, and the standard of maintenance can be improved. The Board is not aware of what redesign and remanufacturing work has been done or is proposed by Triple Five.

II. THE ACCIDENT

The accident that occurred on June 14, 1986 took the lives of three people and seriously injured a fourth. In reconstructing the event, the Board has depended upon the investigations conducted by the Edmonton City Police and by Dr. C.J. Montgomery, P.Eng., and on the reports of others riding in the accident train, the operations personnel on duty at the time, and eyewitnesses.

Evidence was heard from eight passengers of the accident train, Yellow Train No. 1. Generally, the passengers agreed that they first became aware of a problem with the ride shortly after the train passed through what is known as the third braking station. They heard a loud banging noise and the screeching sound of steel on steel. The train began to jerk and slow down as it proceeded toward the vertical loop that follows the third braking station. Some of the passengers said they were aware of a burning rubber smell and some saw sparks coming from the rear of the accident train.

Raymond Chayko, who was sitting in the fourth (last) car of the train and who was seriously injured in the accident, was able to provide a detailed account of the events (826-32). He remembered going through the third braking station, and observed that there were no problems with the ride up to that point. According to Chayko, immediately after the third braking station, the fourth car swung off the track to the right, where it struck a support column. Chayko's recollection was that his lap bar released at this point and he was forced into a standing position in the car. The car then swung to the left across the tracks and struck another column, at which point Chayko was thrown from the car. He landed in a compressor room adjacent to the ride, where he was subsequently found by paramedical personnel. Chayko indicated that his lap bar had not been checked at the commencement of the ride by an attendant, but that he checked it himself and the lap bar was in fact locked.

Some of the passengers of the accident train who gave evidence indicated that they thought the ride was faster than it had been during previous rides they had taken. One passenger indicated that he felt a vibration earlier in the ride during which the accident occurred (1827). The passengers had differing recollections as to whether or not their lap bars had been checked at the start of the ride.

The eyewitnesses generally agreed with the description of the accident as outlined by Chayko, and one particularly corroborated the observation that the accident train had passed completely through the third braking station (1907). A witness who had been standing on the observation platform near the operator's console described a clicking noise that he heard coming from the accident train as it began its final run that night (1991-6). This witness, Emile Doucette, is an experienced Edmonton Transit driver who has operated LRT trains. Three of six witnesses who had ridden a yellow train on the day of the accident also reported hearing a noise described as banging or clicking (2003-5) (2017) (2023).

David Smith was the operator on duty at the time of the accident. He testified that at approximately 8:10 p.m. on June 14, he heard a clanking noise ("metal on metal") coming from Yellow Train No. 1 as it went underneath the Fireball ride, a ride located in the vicinity of the coaster ride operator's consol (2840). He was certain that the train was Yellow No. 1 and that he heard the noise twice from the same train. Smith shut down the ride and called for a maintenance person to assist. Al Zylstra, a maintenance electrician, responded and Smith testified that he sent the train around fully loaded while he and Zylstra listened (2845). They did not hear anything and Zylstra told Smith to continue operating the ride (2946).

Later that evening, Smith stopped a yellow train on the updrive because a generator belt on the train had broken (2847). (The generator is a non-essential part of the train.) He thought at the time that the train he had stopped was Yellow Train No. 1, but he discovered after the accident that it was Yellow Train No. 2 (2838). (The coaster is equipped with six trains. Two are yellow, two are red and two are blue.) There were four trains running on June 14 and Smith's recollection was that the order that evening was Yellow No. 1, Red No. 3, Yellow No. 2 and Blue No. 5. However, after viewing a police photograph of the ride area taken shortly after the accident, Smith was satisfied that the order was actually Yellow No. 1, Blue No. 5, Yellow No. 2 and Red No. 3 (2874). Even though he was subsequently shown to have been confused about the identification of which yellow train was stopped on the updrive, Smith was still sure that he had listened to a noise in Yellow Train No. 1 about 8:00 p.m. that evening (2849).

Dean Jordan was the loading attendant at the roller coaster on the evening of June 14. He testified that early that evening he had heard a strange noise, which he described as a clanking noise, coming from a yellow train (2904-6). Although he recalled that the noise came from a yellow train, he was not sure which yellow train it came from. He heard the sound from the same train on two different occasions. A ticket attendant, Cameron Kapty, also heard noises, which he described as a scraping of metal (2924-6). He heard the noises twice, and said that they came from Yellow Train No. 1. He and Jordan told Smith, the ride operator, about the noises. The unloading attendant present on the evening of June 14, Garry Cunningham, testified that he did not hear any unusual noises from the roller coaster prior to the accident (2944). As well, none of the operators or attendants who worked at the roller coaster during the day shift on June 14 heard any unusual noises from any of the trains. Randy Smith, who operated the coaster on June 13, testified that he did not hear any unusual noises during his shift.

Al Zylstra testified on two occasions. Zylstra, an electrician, was the only maintenance person on duty in Fantasyland on the evening of June 14 (2542). Prior to June 14, Zylstra was still being trained with respect to electrical maintenance on the roller coaster and he had done the morning electrical check of the roller coaster only once, with another electrician (2513). He acknowledged that he was initially confused regarding which train he had removed a generator from, but that he later confirmed that it was in fact Yellow Train No. 2 (2516-7) (2537).

With respect to the report from David Smith that there was an unusual noise in one train, Zylstra testified that Smith did not know at the time which yellow train was making the noise (2517). Zylstra believed that he first listened to Yellow Train No. 2 and returned later to listen to Yellow Train No. 1 (2518). He did not hear anything unusual on either occasion. Zylstra's statement to the police (Ex. 125 dated June 18, 1986) said that he did not know which yellow train he had listened to in response to the inquiry from Smith.

In his testimony before the Board, Zylstra stated that he was convinced that he had listened to both yellow trains on the evening of June 14. He said that he had intended to listen to both trains and it was this intention that led him to believe that he had listened to both (3359).

A description of the accident has been provided by Dr. C.J. Montgomery, P.Eng. and is contained in Exhibit 217. At the beginning of the investigation, Dr. Montgomery was retained for a short period by the Elevators and Fixed Conveyances Branch of the Alberta Department of Labour. Subsequently, Dr. Montgomery worked for the Attorney General's Department of the Provincial Government and this arrangement lasted until about mid-September. After that, he was retained by the Board of Inquiry.

The main intent of Dr. Montgomery's reconstruction of the accident was to provide a background that would assist in leading to an identification of the technical issues that had to be addressed. Thus, it is based to a major degree on the physical evidence that was present at the site immediately following the accident and on the police reports, rather than on the evidence of the eyewitnesses.

The lack of any evidence such as gouges, scratches, and other marks on the tracks and supporting structure prior to Brake Station No. 3, as noted by Montgomery in Exhibit 217, supports the evidence of the eyewitnesses and train occupants that the accident train passed safely through that location. Equally important, if the train had not been in the normal position relative to the track before entering Brake Station No. 3, the relatively tight clearance between the train and the fittings of the brake station meant that damage would have occurred in the brake station. None was present.

The first physical evidence that the train was in trouble was a deep gouge in the central support tube for the track at a location approximately 5.8 m beyond Brake Station No. 3. Inspection of the accident train itself showed clearly that the bogie assembly on the left-hand side of the last car in the train had separated from the main portion of the car.

Each train consists of four cars and each car carries four passengers. The first car has wheel assemblies both at the front of the car and at the rear. The second car has wheel assemblies at the rear, but is attached to the back of the first car by a tongue arrangement. The third and fourth cars are identical to the second car. A typical bogie assembly, used for all locations except the front of the first car, consists of six individual wheels on each side of a car. The six wheels on one side of the car operate independently of the six wheels on the other side of the same car. The wheels are arranged in pairs.

The largest pair sits on top of the track and they act as the running wheels. Another pair of smaller wheels is positioned horizontally and serves to prevent lateral movement of the car off the track. The third pair is nearly vertical and is located on the underside of the track. It serves to keep the car from moving upward off the track. Reference to a "bogie assembly" refers to the general arrangement of six wheels and the heavy steel castings that keep them in the desired configuration.

Montgomery's opinion, based on the physical evidence, is that separation of the left-hand bogie wheel assembly occurred after the last car passed through Brake Station No. 3 and just before the deep gouge noted 5.8 m beyond the brake station.

After the bogie assembly separated from the undercarriage, the fourth car was no longer restrained on the track and it was free to rotate in any direction, restrained at its front end by the tongue to the third car but loose at the rear end. Centrifugal forces pulled the rear of the car across the track and caused it to graze the side of a tower support column adjacent to the track. The evidence of Montgomery is that it is likely that the left-hand bogie assembly, now separated from the fourth car, stayed on the track for a short interval of time. It moved down the track, however, rotated out of its normal position, became disengaged from the rail, and fell to the floor of the building.

Each car of the train has a lap bar release button outside the car, relatively low down so as to be out of the reach of passengers. Montgomery speculates that the first impact of the car against the supporting column triggered the lap bar release mechanism when this button hit the support. This speculation is consistent with the testimony of Chayko that his lap bar released from the locked position at the time of the first impact.

A plausible description of the action of the train as it moved on down the track and finally came to rest in one of the vertical loops is contained in the Montgomery report. It is based on the markings, damage, and so on, that were observed on the rail and supporting structure between Brake Station No. 3 and the final resting place.

The investigation conducted immediately after the accident by Edmonton City Police generally corroborated the opinion as to the accident sequence arrived at later by Montgomery. The police investigation turned up the important information that four cap screws were lying on the floor of the coaster installation immediately after the accident. These cap screws were of a size and type similar to those used to hold a vertical trunnion (axle) in position in the bogie wheel assembly. They had yellow paint on their heads. The location from which these four cap screws could have come was investigated immediately by the police and later by Montgomery, and it was established that they indeed came from the left-hand vertical axle assembly of Yellow Train No. 1. This conclusion was accepted by all relevant witnesses who appeared before the Inquiry.

The hypothesis put forward by Montgomery is that the four cap screws loosened and dropped out of their connection plate. The assembly is such that these four screws are essential to the integrity of the connection. If they are not present, the vertical axle can lift out of its housing should uplift occur. If this happens, that bogie wheel assembly separates from the car. Here again, all witnesses who testified on this point were in agreement: it was the loss of the four cap screws in the left-hand vertical axle assembly that was the immediate cause of the accident that occurred on June 14, 1986.

The Board is in agreement that the accident happened as a consequence of the loss of four cap screws in the left-hand vertical axle assembly of the last car in Yellow Train No. 1.

The loss of the cap screws allowed the vertical trunnion (axle) to separate from its housing the first time uplift occurred. The accident took place immediately after the train had passed through Brake Station No. 3.

In the opinion of the Board, there was no evidence that would lead to the conclusion that passengers had been improperly placed in the cars or that lap bars had not been engaged.

III. TECHNICAL ISSUES

It is fortunate that the evidence brought before the Board is in general agreement as to the immediate cause of the accident. There is a consensus among the principal witnesses who testified on this point (eg. Montgomery, Strulik, Hoogensen, and others) that the cause of the accident was the loss of four cap screws that had held a retaining plate to the bottom of the housing containing a vertical trunnion (axle) in the bogie wheel assembly. It was the loss of these cap screws in the left hand bogie of the last car of Yellow Train No. 1 that allowed the vertical trunnion to lift out of its housing just after the train passed Brake Station No. 3. This resulted in a lateral, "whipping" motion of the last car, and produced the subsequent tragic results. It is not possible to reconstruct with certainty the exact sequence of events that followed the release of the bogie wheel assembly from the last car. In the final analysis, however, that sequence is not an issue in determining how the four cap screws became loose. Those who wish to pursue the accident sequence further will find the best description in the Montgomery report (Ex. 217).

Examination of a representative number of cap screws still in place in the various trains of the coaster setup revealed that, while a large number of screws were apparently "properly" installed, there were also a number of screws that did not have the prescribed installation torque, and two that were in fact broken (Ex. 217, App. D). Subsequent examination of the screws at a more detailed level showed also that a number had fatigue cracks (Exs. 207, 217, 263). Taking all this together with the fact that four screws actually loosened and fell to the floor, it is clear that a serious overall problem existed in addition to the immediate one of the four loosened cap screws.

A properly designed connection, such as the one in question, should meet at least the following requirements: (1) there should be no possibility of failure by fatigue, vibration loosening, or fracture due to overload during the design lifetime of the structure, and (2) on the assumption that the design process cannot be perfect, it is necessary that the connection be reasonably accessible for inspection, that an inspection procedure be spelled out, and that such inspection procedure be developed on an understanding of all possible failure modes. The requirements for the designer under item 1 are straightforward in principle. Specifically, and in the case of the type of connection in question, he must predict as closely as possible the forces that are likely to be present in the connection, and he must then ensure, by way of calculation, that failure by fracture, fatigue, or vibration loosening is remote.

It is clear from the evidence that Werner Stengel was the engineer who developed and used the mathematical model that predicted the forces on the cars of the trains and on the components of the cars. A review of the documents indicates that this was done in a professional and thorough manner. Subsequent measurement of actual forces in components of one of the trains, done by other parties (Exs. 213, 266), has shown that the calculations produced by Stengel were in reasonable agreement with these measured values.

The approach to ensuring that vibration loosening should not occur appears to have depended upon two elements, the preload in the cap screw as a consequence of its normal method of installation and the addition of thread adhesive. There was little or no evidence in the design calculations of the designer's intentions on these points. It can, however, be assumed that the cap screws would be installed in the connection in a manner that conformed to the German specification DIN 4112, Temporary Structures - Code of Practice for Design and Construction: the design drawings indicate torque values appropriate for this size and strength grade of fastener. It must be noted, however, that the "standard" method of installation, which is intended to produce a certain value of preload in the screw, assumes certain conditions that were not met in this connection. It assumes that fastener threads are lightly lubricated (the fastener threads in the connections under investigation were galvanized, a procedure prohibited for fasteners of this strength grade, and they were lubricated further by thread adhesive), and that parts to be joined are in intimate contact at the start of the installation. As will be treated later in this section, the presence of a small gap between the retainer plate and the underside of the trunnion violates this installation procedure. Thus, even if the design installation torque was applied to the fasteners, it cannot be stated that they necessarily then had the minimum preload assumed by the designer.

The second element in the designer's defense against vibration loosening seems to have been the addition of a thread adhesive. Thread adhesives are used extensively in certain industries, notably the aircraft industry, and this can be a good solution in some cases. As discussed in more detail in Part VI of this Report dealing with manufacturing, in this instance there is evidence that the thread adhesive was not properly applied and that it did not result in a loosening torque value expected by the designers (in this case, Anton Schwarzkopf). Moreover, there was not a single piece of written material that came before the Board - drawings, specifications, inspection manual, inter-office memoranda, etc. - that ever refers to the application of thread adhesive. The principal evidence before the Board concerning the thread adhesive is that there was verbal communication between Schwarzkopf GmbH staff and B.K. Maintenance staff. The evidence is that the owner was told, through William Keur, that thread adhesive was used, that these joints needed to be inspected only visually, and that, because of the presence of thread adhesive, a huge amount of force would be required to back off the screws. If nothing else, the procedure was deficient in that it did not tell the owner what he would need to do if he had to reinstall a fastener in this connection. It is unreasonable to think that during the entire lifetime of the coaster this particular type of connection would never be opened up.

It must be noted also that "normal" practice in the case of mechanical fasteners subject to possible vibration loosening is to have some mechanical means of ensuring that the fastener will not loosen: locking of the screw head, wiring of heads, cotter pins, etc. The four cap screws in the critical connection had none of these devices. Their integrity against vibration loosening lay entirely in the defenses of fastener preload and thread adhesive; neither of these items could be inspected in any worthwhile way in the as-built cars.

Wolfgang Viebahn, the plant manager at Schwarzkopf GmbH during the manufacture of the coaster, testified (4435) that Karl-Stephan Stein was the person responsible for making decisions such as the selection of a method to be used for the securing of fasteners. (Stein was the production manager at the plant during the construction of the coaster). Because Stein did not testify before the Board, this position put forward by Viebahn could not be explored further.

The design process that went on in Germany during the construction of the cars and the track for the Triple Five roller coaster appears to have been a collaborative one. As has already been noted, the calculation of stresses in the various parts of the track and its supporting structure was the responsibility of Werner Stengel. Bachschmidt, described as the chief designer at Schwarzkopf GmbH (4298), was responsible for the production of the track and supporting structure in the plant. Those involved in the design of the cars were Stengel, Anton Schwarzkopf, and the firm IMA. The latter was represented principally by Anton Abele and Konrad Klarl, and Klarl was the usual contact.

There was no evidence before the Board that suggested that the track itself or its supporting structure contributed to the accident in any way. Indeed, the quality of workmanship in the as-constructed track was reported to be high (Ex. 217).

The flow of ideas and work among Anton Schwarzkopf, Werner Stengel, and IMA seems to have been as follows (4298-9) (4449): Anton Schwarzkopf was the person who generally developed the concepts as to how things should be done or how the various parts of an assembly should be arranged and connected. This usually culminated in a preliminary sketch or drawing. The firm IMA took these rough sketches or drawings and made shop drawings, the drawings from which the parts could actually be manufactured and then assembled. (Shop drawings are also referred to as production drawings (4452).) The firm of Stengel would then use the shop drawings in order to make design checks, that is, they would calculate stresses, evaluate fatigue life, etc., using the dimensions and arrangement of parts as established by IMA. Naturally, this sequence had variations. For instance, Abele testified that Anton Schwarzkopf discussed his ideas and drafts with Steininger of the Stengel office before he came to IMA to ask for preparation of shop drawings (4450). It is also evident that the interaction among Stengel, Anton Schwarzkopf, and IMA was an iterative one, as required by the realities of the problem under discussion.

The role of fastener preload as a defense against vibration loosening has already been mentioned. There is a second and equally important reason why a high-strength fastener is expected to have a high internal preload in the installed condition. High-strength fasteners of the type used for the critical cap screws, properly installed in a "solid" connection (no gaps or compressible material, no separation of parts under normal loads) will experience only a small fraction of any externally applied load. Therefore, while the external parts of the connection are undergoing changes in stress that are directly related to the changes in force that occur, the fasteners will be subjected to very little change in force (and, thus, stress) during the same loading changes. For the usual proportions found in a high-strength bolted connection, the change in load in a properly installed fastener will be less than about ten percent of the external load. Under normal operating loads, the fastener is therefore protected against significant additional forces being applied to it. The designer bases his calculations for fastener static strength or for fastener fatigue life on these expectations.

In simplified terms, fatigue strength is related to only three factors: the number of load cycles imposed, the change in stress that takes place on the part in question during those load cycles, and the stress concentration presented by the part. In this case, the stress concentration is embodied in the detail present, that is, a threaded fastener. In practical terms it is not a variable; screws will be used. The number of load cycles that the designer selects as a criterion is usually prescribed by the governing specification. (In a case like this, the designer might strive to have an "infinite" fatigue life for his part.) Thus, the number of load cycles also is not a variable, at least within reasonable boundaries. The principal variable that is within the control of the designer is, therefore, the stress range to which the part is subjected. As outlined above, if a properly installed high-strength fastener is used, the fastener preload has the effect of limiting the actual stress range seen by the screw to a small fraction of the applied external load. It has already been mentioned that because of the thread conditions and the presence of the gap between the underside of the trunnion and the retainer plate, in this case the designer cannot know with confidence that the application of a prescribed amount of torque has produced the minimum specified preload, a preload that is necessary for proper functioning of the connection.

In the case of the critical connection in the cars of the Triple Five coaster, there was not only a gap present in the assembly, there was material more compressible than steel in the system. This was the bronze bushing. The two experts giving testimony on this point (Hoogensen and Montgomery) differed substantially in their estimate of how the cap screws in this installation reacted to an externally applied load. Resolution of the difference, while academically interesting, is not necessary in order that the Board reach its conclusions.

When selecting the bearing surrounding the vertical trunnion, the manufacturer (Schwarzkopf GmbH) permitted the alternatives of a steel roller bearing set or a bronze bushing arrangement. The evidence before the Board is that the bronze bushing alternative was introduced by Anton Schwarzkopf because a sufficient number of the steel roller bearings were not available within the required completion time for the ride (4481) (4549).

In a discussion concerning wear in the bushings used for the lateral guiding wheels, Werner Stengel testified that he felt that Anton Schwarzkopf intended that a harder bronze than was actually employed (with better wear resistance) be used in these bearings (5138-9). The TUV report on their inspection of the Triple Five coaster (Ex. 213) commented on excessive wear in the same bronze bushings.

Both Montgomery and Hoogensen commented on the wear in the bushings taken from the accident train. Because it is not possible to establish the original dimension of the bushings, only qualitative statements about the amount of wear can be made. Referring to the bushings taken from Bogie 4AL, for example, Montgomery observed that there was a "substantial amount of wear from relative rotation on the inside diameter" (Ex. 217, p. 43). Hoogensen also made comments about wear, although many of his observations had to do with the contact area between the bushing and the keeper plate, not the contact surface between the bushing and the trunnion. Figures 4.8.2 and 4.8.3 in the Hoogensen report (Ex. 266), which are photographs of a bronze bushing from the accident car, do show that visible wear has occurred on the bushing side of that contact, however.

Stengel testified that his records indicate that the static calculations for the triple loop roller coaster were completed by his firm on May 22, 1985 (4949), about a month prior to the bankruptcy of Schwarzkopf GmbH. He also stated that he understood the introduction of bronze bushings as an alternative occurred sometime after that date (4983). Stengel's firm did not redo the static calculations in relation to the use of bronze bushings on the three loop roller coaster for Triple Five. Such calculations were done at a later date with respect to the four loop roller coaster which used the same design for the vertical axle assembly (Ex. 230, p. 243-C) (4982-4). It was Stengel's evidence that his employee, Steininger, did some rough static calculations with respect to the alternative of bronze bushings sometime after March 26, "but Steininger checked only to transfer the forces about the bearing, not the function and all the other parts, because that was not our duty" (5119).

The bearing arrangement used (either alternative) required preloading of the bearing itself, and this was the reason the gap between the keeper plate and the underside of the vertical trunnion had been introduced into the assembly detail (5004). The possible influence of the gap upon the fastener preload has already been mentioned.

Use of the bronze bushing alternative introduced another problem. All of those who testified on this point agreed that the trunnion - bushing assembly was intended to turn on the outer surface of the bushing, that is, the interface between the outside diameter of the trunnion and the inside diameter of the bushing was not to permit relative rotation or translation between these parts. To accomplish this, a so-called interference fit would be required. Those involved in the examination after the accident, Montgomery (Ex. 217, p. 43), Breed (3940), and Hoogensen (5417), as well as those involved in the design, Stengel (5030, 5173) and Abele (4464), agreed as to the need for the assembly to work in this way. Abele testified that the decision to require that the bronze bushings be pressed onto the steel trunnion was discussed among Klarl, Schwarzkopf and Steininger.

The importance of assembling the component parts in this way is that the entire assembly, that is, the vertical trunnion, the bronze bushings, and the keeper plate attached by four cap screws to the bottom of the vertical trunnion, acted as a unit. Thus, while the vertical trunnion and bushing permitted rotation of the bogie assembly about a vertical axis, there would be no relative movement between the trunnion and the keeper plate at its lower end. As will be described subsequently, if relative movement is allowed to occur, there will be a tendency for the cap screws holding the keeper plate to the trunnion to loosen and fall out.

The Montgomery report (Ex. 217) provides a description of the expected functioning of the bushing - vertical trunnion assembly. Application of the limiting tolerances shown on the drawings for the bushings and for the trunnion shows that the fit produced is actually what is termed a transition fit. While most of the assemblies built to the specified tolerances would have to be pressed together, that is, the bushing would have to be pressed onto the trunnion, there is a range of tolerances which actually provides a clearance between the parts. Assuming that the bushing and the trunnion are aligned concentrically, it can be noted that the maximum clearance that could occur between the bushing and the trunnion if each were machined to the most unfavorable tolerance would be 0.005 mm (equal to two ten thousandths of an inch). This is a very small clearance, scarcely within the capability of measurement in a laboratory.

In the opinion of the Board, it is reasonable to expect that the specified tolerances for these components would lead to an interference fit between the two parts in almost all cases, and hence the designers' expectations that the two parts would not turn relative to one another would be met. The Board is not able to comment as to why an interference fit was not specified so that all cases would be manufactured such that clearance could not occur.

Measurement of the actual trunnions and bushings in the accident train was made by both Montgomery (Ex. 217, p. 42) and by Beesley (Exs. 301, 306). The Montgomery measurements were actually done under his direction by the Curtis Hoover Ltd. machine shop and they have been criticized because of the lack of sensitivity of the instruments and the measurement technique used and because of the fact that the diameters of the trunnions and bushings were only measured at one location and in one direction in each case. The measurements done by Beesley were done using a technique that could be expected to produce extremely accurate results and his measurements were more thorough in the sense that the diameters in each case were measured at a number of locations, both circumferentially and along the length of the part. Beesley's area of expertise is metrology, the science of measurements (5817).

Using the Curtis Hoover measurements, which were the only ones available at the time he produced his report, together with information from other sources (5794-6), Montgomery concluded that the inner diameter of the bronze bushings was made larger than intended and the outer diameter of the vertical axle was made smaller than intended (Ex. 217, p. 42). The result of this would be that the bushing would turn freely on the vertical trunnion. With respect to the bushings and trunnions taken from the accident train, Montgomery observed that this rotation was indeed physically possible and, in some cases, it was observed that the vertical trunnion had so much play that it could wobble within the bushing. The fit problem may have been exacerbated by the occurrence of wear in the bronze bushings. As has already been noted, there were reports of excessive wear in other bronze bushings of the Triple Five trains and the observations by Montgomery and Hoogensen that wear had taken place in the vertical axle bushings taken from the accident train.

Beesley's measurements of the trunnions taken from the accident train, identified as 4R, 4AL, and 4L, indicate that the trunnions are round and that there is consistency in the diameter dimensions among the three. The mean out-of-tolerance was measured by Beesley to be 0.046 mm. The specified maximum out-of-tolerance is 0.034 mm. Thus, these trunnions have a mean value of the measured diameter that is less than that specified. Furthermore, of the eighteen individual measurements of diameter taken by Beesley, no measured value was within the prescribed tolerance limit. The measurements done by Beesley were performed at the request of Clifford Anderson, a consulting mechanical engineer who specializes in failure analysis and accident investigation (5099). Anderson, testifying on the Beesley measurements, said that he considered that the trunnions measured by Beesley were probably close in size to their manufactured state (5136). Although these measurements were taken on axles that had been used, the Board concludes that the amount of wear on a steel trunnion in the length of time in use in this case is likely to have been very small. In the opinion of the Board the vertical trunnions taken from the accident train were manufactured to a diameter less than had been specified.

Beesley also took measurements of the bushings that correspond to each of the trunnions. On each bushing he took three measurements of the diameter at each of three locations along the length of the bushing. These measurements indicate clearly that the interior surface of the bushing is not round and that the diameter is different at different locations along the length of the part. Because bronze is a relatively soft material and because these bushings may have been subjected to unusual forces at the time of the accident, no absolute conclusion can be drawn as to the state of the bushings at the time they were manufactured. It would be unlikely that the bushings were manufactured to an oval shape, but just what their diameter was upon installation cannot now be established absolutely. However, the Board considers that a bushing in an oval condition at the time of measurement and nowhere within the prescribed tolerances is very likely to have been likewise out of tolerance in its undeformed, circular, shape.

A comparison that can be made is to use the Beesley measurements of both the trunnions and the matching bushings and to see if, within their present state, there are any locations where clearance between the two elements occurs. Some judgment as to where the comparisons can properly be made is necessary. However, a reasonable selection is to match the upper end of the trunnion with the top end of the upper bushing, the midpoint of the trunnion with the lower end of the upper bushing, the midpoint of the trunnion with the top end of the lower bushing, and the bottom end of the trunnion with the lower end of the lower bushing. This produces a total of twelve points of comparison. At eleven of these locations, clearance is present and at the remaining location there is a small amount of interference (0.007 mm). The comparison was made selecting the dimensions in each case that would be least favorable to identifying a condition of clearance. As an alternative comparison, a bushing made to the mean value of the tolerances prescribed would also have a clearance fit if used with the trunnions taken from the accident train, assuming the average measured trunnion diameter.

Further evidence before the Board concerning the fit of the trunnion - bushing assembly is the testimony given by Stengel concerning his observations made when the bogie assembly of a blue train was disassembled immediately following the accident (5176). He reported that a large force was needed to press the bronze bushing off of the trunnion in that instance. Thus, there was at least one instance in the Triple Five coaster where the desired fit had been obtained.

As well, Hoogensen testified that in order to conduct certain tests, he had occasion to take apart a bogie assembly from Blue Train No. 5 (5443). At that time, he observed that no force was required to take the trunnion out of the assembly; in fact, the bushings could be removed by hand. The fit in that assembly was clearly not an interference fit.

In summary, the Board considers that the trunnions measured from the vertical axle assembly of the accident train were not within their prescribed tolerance when they were manufactured. It is not possible to conclude absolutely whether or not the corresponding bushings were manufactured within their prescribed tolerances. Notwithstanding the observation that the conditions of the bushings at the time they were manufactured cannot be established absolutely, the evidence of the trunnion sizes leads the Board to the conclusion that the condition of the trunnion and bushing assemblies in the accident train was such that there was clearance at the interface of the two elements.

The expert evidence differs somewhat as to the mode of vibration loosening, but there is agreement that both lateral translation between the keeper plate and the vertical trunnion and rotational movement between these same elements are the mechanisms by which vibration loosening of the cap screws has taken place. Montgomery places the major emphasis upon the translational mode, but acknowledges that the rotational mode also contributes, whereas Hoogensen and Breed reverse the emphasis. Stengel's evidence perhaps is less clear as to which is the primary mode, but he also agrees that the vibration loosening was triggered by one or both. This is another occasion wherein no conclusion as to the correctness of any point of view can be made. It is also another situation wherein it is not necessary to resolve the correctness of one or another of the points of view.

The Board is able to conclude that the vibration loosening occurred as a result of either or both possible mechanisms of relative movement between the vertical trunnion and the keeper plate at its lower end. This movement was present in the assembly because there was an improper fit between the bronze bushings and the steel trunnions. The Board has concluded that the trunnions taken from the accident train were machined too small and therefore a clearance was created between the trunnion and its surrounding bushings. The presence of the gap between the keeper plate and the trunnion affected the amount of movement that could occur as rotational or translational movement took place between the trunnion and the bushing.

The clearance problem in the accident train may have been exacerbated by bushings that were machined too large, but the bushing size as manufactured was not established conclusively. Even for bushings and trunnions that were machined within the prescribed tolerances, it is a possibility that the fit class selected was inappropriate because it did allow in some cases for clearance, and it is also possible that the bronze selected had poor wear resistance.

In addition to the use of an interference fit between the vertical axle and the surrounding bronze bushing, the designers intended that thread adhesive be used and that there be a high level of preload in the fasteners. There is evidence before the Board that the thread adhesive was not properly applied. The presence of a gap between the bottom of the trunnion and the face of the keeper plate, the presence of the bronze bushing, and the use of galvanized screws all affected the bolt preload. Thus, the designers' intended mechanisms for prevention of vibration loosening were jeopardized, even in an assembly that might have had no clearance problem.

The principal technical experts, Montgomery and Hoogensen, agree that the forces present during the vibration loosening of the four critical cap screws are also the forces that produced the fatigue cracking of cap screws in other vertical axle assemblies. The details of the fatigue cracking mechanism have been addressed in specific terms by Hoogensen (Ex. 266), Hamre (Exs. 263, 294), and Wayman (Ex. 217 , App. C; Ex. 279).

The evidence of Wayman was that the fracture surface of the cap screw found on May 20 "consisted of a flat region occupying more than half of the cross-section and a region elevated above the flat. In the optical microscope the flat regions of both bolts exhibited 'clamshell' markings typical of metal fatigue" (Ex. 217, Appendix C, p. 2). (Wayman is discussing both the cap screw found on May 20 and another similar screw taken from car 3 in Red Train No. 4). At the same location, the report goes on to say, "In the scanning electron microscope, the flat regions of both bolts exhibited characteristic fatigue 'striations' (Fig. 2)."

In his report dated September 30, 1986, Hamre concludes with respect to the screw labelled by Police identification number E109 (the May 20th screw, Ex. 168) that, "the fracture surface exhibited ratchet marks and concentric striations, indicating that failure had probably propagated by fatigue" (Ex. 207 p. 23).

As a result of some of the evidence given by Hoogensen with respect to the same screw, both Hamre and Wayman were asked to examine the fracture surface once more. In Exhibit 296, Hamre reported to the Board that:

> "The crack seen initially on a metallographic cross section has been further examined and is concluded to be the result of propagation by fatigue. As no evidence of dimple rupture

> was found anywhere on the crack surface it is further concluded that the screw has not cracked as a result of overload." (Ex. 296, p. 30)

Wayman reported back to the Board that:

> "... I am able to reconfirm my belief that both of these had failed after fatigue cracks had propagated across a significant fraction of their cross-sections. In E-109 the fatigue crack occupied some 80% of the cross-section and in E-111 at least 50%. These observations are in accord with those of Dr. E.C. Hamre as discussed on pages 93, 94, and 95 of his report to Dr. C.J. Montgomery." (Ex. 279)

In his report, Christian P. Hoogensen drew a different conclusion with respect to the broken cap screw that came from car number 4 of Red Train No. 4. He states his conclusion as follows:

> "The two cap screws which had failed from the red train #4 had clear signs of being over-torqued or overloaded. The cap screws from train #4, cap screws three and four ... do show ratchet markings and progressive cracking. The final fracture area is, however, very large, and has the appearance of overloading. This can not be confirmed without examining the other fractured half by metallographic techniques". (Ex. 266, p. 135)

However, in response to questioning from the Board, Hoogensen's testimony was as follows:

> "Q. Are you saying, Mr. Hoogensen, have I concluded correctly from what you said, that you've identified that part of that failure is a fatigue failure and that when the area was sufficiently reduced, it failed by fracture which you call shear?

> A. That's correct, what it means, and I would like to come back on the fatigue aspect you mentioned. What we see after this line, when we see that fracture dives away on a 45 degrees, as I call the remainder fracture, that's a large area. It's indicating that it was subject to the high loading.
>
> As far as the indication is concerned, I make differences between fatigue, a low cycle fatigue and an overload. A low cycle fatigue is when we are seeing less than 1 to 10 or less than 100,000 cycles, then we call it the low cycle fatigue. Of course, we always in the regime of a low cycle fatigue because simply we didn't have the cycles.
>
> As far as overload is concerned, when I see in the root of the thread, as we will demonstrate, I will show you, small areas which are stretched, then I don't even consider the low cycle fatigue, I say it's an overload. But that's an arguable part. You can say, well, low cycle fatigue is ten cycles is still low cycle fatigue." (5308)

Later in his testimony, and in response to questions by counsel, Hoogensen said:

> "A. ... But, there is not very much of a difference, as I just mentioned to Dr. Kulak, when you have five cycles and that causes a crack to initiate and propagate and say, well, this is low cycle fatigue, I would prefer to call it plain overload, but it's a matter of semantics.
>
> Q. So while there is a difference in semantics, is the difference in the opinions that significant?
>
> A. No, I don't think all together, sir." (5311)

According to this testimony, Hoogensen agrees that what he calls "overload" could, in the circumstances of a very low number of load cycles, also be called fatigue by someone else. The Board believes that the number of load cycles is likely to be low since Red Train No. 4 had only operated for a short period of time. Based on all of the evidence, the Board is of the opinion that the fractured cap screw discovered on May 20 failed as a result of fatigue.

Hamre and Wayman concluded that the fracture surface of the May 20 cap screw is almost entirely one resulting from fatigue and that the change in direction of that fracture surface can be explained by the presence of both bending and axial load effects. Montgomery's analysis of the force system in the vertical axle assembly that loads the fasteners identifies that a significant bending effect could be present, especially as translational displacement takes place between the trunnion and the keeper plate.

A final significant feature of the as-built assembly concerns the thickness of the lower keeper plate. Werner Stengel's evidence is that he expected the keeper plate to be manufactured with a finished thickness of 20 mm (4978). It was on this basis that a strength check of the plate was carried out by his firm. In the as-built condition, the keeper plate was, in fact, only 12 mm thick. As the party responsible for the integrity of this part, Stengel's concern with the existence of the thinner plate was two-fold. Potentially, both the static capacity of the part (5058) (5127) and the fastener fatigue life (4980) are affected.

The use of a 12 mm thick plate (with only 4 mm of material under the head of the countersunk screw) instead of the 20 mm thick plate (with 12 mm of material under the head), as apparently intended by Werner Stengel, evidently did not affect the static strength of the plate within the life of the ride.

The increased deflection of a 12 mm thick plate as compared to a 20 mm thick plate could potentially have had a significant effect on the fatigue life of the cap screws, however. It is known that local bending can have a large influence on bolt fatigue life. In this case, it has been established by experiment that application of the prescribed torque of 69 Newton-metres to four 10 mm diameter screws in a 12 mm thick plate produces a rotation of the keeper plate at the fastener line of about 0.29 degrees (Ex. 294). If it is assumed that the screw length under the head is 4.5 mm, a dimension consistent with the real conditions, a rotation of the cap screw head by this amount would theoretically produce a bolt stress in excess of the yield strength of the material. While this does not especially relate to fatigue life, it is indicative of the severity of the problem.

For the Board, the most compelling argument that the existence of a 12 mm thick keeper plate did play a role in the fatigue life of the screws is that Montgomery, Hamre, and Wayman all associate the observed fatigue failure surfaces with the presence of some bending. A rational explanation for the presence of bending is that the head and a short portion of the adjacent shaft of each screw was bending under the action of fluctuating loads because of the flexibility of the 12 mm thick keeper plate. In the opinion of the Board, the use of a 12 mm thick keeper plate contributed to the presence of fatigue cracks in the lower keeper plate screws of this roller coaster.

IV. ACQUISITION

In the opinion of the Board, Triple Five started out with the intention of acquiring the best roller coaster available, from the manufacturer with the best reputation in the business. Unfortunately, this laudable intention was frustrated by a series of unfortunate circumstances, and the result was that Triple Five acquired a coaster which was defective in design and defective in manufacture.

Many of these circumstances were out of Triple Five's control, but some were not. What a buyer acquires may be influenced by who he is dealing with and the circumstances of the acquisition. A question that must be addressed is whether the acquisition process in this case had a bearing on the fact that a defective product was obtained.

The acquisition of the coaster was a process which extended over several months. It is important to know what happened in this process, because these events are related to various subjects into which the Board was directed to inquire. The first section of this Part outlines chronologically the evidence as to the sequence of events commencing from the time Triple Five decided to investigate the purchase of a roller coaster. The next section deals with issues considered by the Board arising from some of this evidence.

SEQUENCE OF EVENTS DURING ACQUISITION PROCESS

Anton Schwarzkopf operated a family company in southern Germany near Muensterhausen, which over a period of decades acquired an international reputation for excellence and quality in the construction of amusement rides. However, the company's plant and machinery were growing older, and it was experiencing financial difficulties which resulted in its bankruptcy in November, 1983.

After the bankruptcy, the company was operated for a few months by a Receiver (4290). (The first of three receivers referred to in this Report.) The Receiver disposed of the assets, and this company ceased to exist.

Herbert Breidenbach was the owner of five small companies which were located in northern Germany near Cologne. Apparently, the Breidenbach companies were engaged in the business of operating machine shops and in the manufacturing of machinery. Gebr. Breidenbach GmbH & Co. K.G. appeared to be the principal company of the five. Its registered office was in Kuerten, near Cologne. When Breidenbach heard of the bankruptcy of the Anton Schwarzkopf family company, he saw an opportunity and commenced negotiations with the Receiver in the first few months of 1984.

Breidenbach's own financial resources were not adequate to acquire the assets of the Schwarzkopf family company. A realtor and business consultant by the name of Theo Becker provided the financing to Breidenbach in exchange for seventy-five percent of the shares of each of the five Breidenbach companies (4290).

Marianne Becker, wife of Theo Becker, became the owner of the plant buildings and the plant site of the bankrupt Schwarzkopf Company under an Agreement for Sale dated 2nd July, 1984.

A small subsidiary company of Gebr. Breidenbach GmbH & Co. K.G. (incorporated as API Breidenbach GmbH, on 1 February, 1978) changed its name on the 27th of January, 1984 to Schwarzkopf GmbH, presumably to take advantage of the reputation and goodwill of the former family company of Anton Schwarzkopf (Ex. 288).

This Breidenbach company acquired the machinery from the bankrupt company in May of 1984 (Ex. 247), moved into the plant buildings which were being acquired by Marianne Becker, hired a number of former employees of the bankrupt company, and commenced to carry on the same business as had formerly been carried on by the bankrupt company that had previously been owned and operated by Anton Schwarzkopf. Its registered office was changed from Kuerten, near Cologne, to Muensterhausen on the 12th of June, 1984.

The new company, Schwarzkopf GmbH, owned by Breidenbach and Becker, was operated by new management whose business practices appeared to be different than those of Anton Schwarzkopf. Breidenbach was the Business Manager, but after Becker became the controlling shareholder, Becker's friend and financial advisor, Dr. Carmele, was also appointed Business Manager on 28 November, 1984 (Ex. 289) (4287). Breidenbach persuaded Wolfgang Viebahn, whom he had known for 15 years, to return from the U.S.A. to Germany to become plant manager for Schwarzkopf GmbH in Muensterhausen (4283). Viebahn testified that the Breidenbach companies had never before built a roller coaster (4366).

It was with the company Schwarzkopf GmbH, owned by Breidenbach and Becker, that Triple Five contracted to build its triple loop coaster. Although this new company occupied the same building, employed some of the same people, and had changed its name to include the name "Schwarzkopf", it was not the same company which had earned the enviable reputation.

William Keur testified that from 1981 on he had been travelling to Germany to inspect and purchase rides on behalf of Triple Five. Keur stated:

> "The roller coaster was something that the Ghermezian brothers had in mind. So, we travelled" -- "We travelled through Germany

> until I was sick in the stomach from going through, I don't know how many roller coasters, we found the triple looper in Munchen quite exciting, and we came back with that to Mr. Ghermezian with the prints. And he decided that he wanted the Triple Loop Rollercoaster." (215)

And later:

> "Well, I travelled again with Mr. McCarthy to Germany, where we heard that the man who made it his trade, exactly designed roller coasters, tracks, and had quite a good reputation was Mr. Stengel. So we proceeded to meet Mr. Stengel and we asked him whether he was the designer, engineer from the triple looper we saw in Munchen. But he admitted it, and then we came to know the person, asked him about other rides. Through him we got the recommendation to try the Schwarzkopf company, was the best, the longest, no copy cat from nobody. And that is what we went with the Schwarzkopf company. I met Mr. Schwarzkopf in that time." (216)

Keur further stated:

> "...Mr. Schwarzkopf is the only one who has the right to make that particular loop, what the Ghermezian brothers desired." (217)

Werner Stengel, referred to by Keur, is a consulting structural engineer who has been presented as an expert in design calculations for roller coasters. Keur's first meetings with Stengel and Schwarzkopf appeared to have been prior to the bankruptcy of the Schwarzkopf family company. Keur intended to recommend purchase of a coaster from Anton Schwarzkopf and his family company. However, before Triple Five negotiated its supply contract, the Schwarzkopf family company was bankrupt and the new company Schwarzkopf GmbH, owned by Breidenbach and Becker, was endeavoring to establish itself in this business. Michael Mooney of Triple Five was aware that the Schwarzkopf family company had been in financial difficulty, and that he was now dealing with a company owned by Breidenbach (56).

The following are excerpts from Keur's testimony.

> "Q. I take it after you saw Mr. Stengel and Mr. Schwarzkopf in late 1983 and early 1984, you made some recommendation to the Ghermezians or Triple Five?
>
> A. Right.
>
> Q. And what was your recommendation?
>
> A. To bring Mr. Breidenbach and Mr. Schwarzkopf to Canada, so that the final financial dealing could have been done." (225)

And later:

> "Q. And what did you know about Mr. Breidenbach? Why were you bringing him over?
>
> A. Well I had a meeting with Mr. Breidenbach, and that is all I knew from him. In the meantime, nobody in the amusement world in Europe ever knew that Mr. Breidenbach existed.
>
> Q. So Mr. Breidenbach was not a known quantity in the amusement world?
>
> A. No. But Mr. Schwarzkopf is." (226)

Keur also stated:

> "Q. Did you subsequently meet with Mr. Breidenbach?
>
> A. I met Mr. Breidenbach on our second trip when the temperature changed a little bit when I came again, I was introduced to Mr. Breidenbach." (227)

Triple Five had legitimate concerns about contracting with the new company Schwarzkopf GmbH, owned by Breidenbach and Becker, for a coaster to be built in a foreign country (83) (84). Triple Five obtained a credit rating on the parent company, Gebr. Breidenbach GmbH & Co. K.G., which indicated that it owned no real estate, carried on its business in rented premises, and that its maximum credit with its bank was an amount approximately equal to two percent of the cost of the roller coaster to be built by its subsidiary for Triple Five. The credit rating stated, "Negative information about the Breidenbach GmbH & Co. K.G. has not been obtained" (Ex. 247). It appears that Triple Five was negotiating with small companies which were then solvent, but which did not appear to have very substantial financial resources.

When Breidenbach came from Germany to Edmonton to sign the coaster contract with Triple Five, he brought Anton Schwarzkopf with him (53). This appeared to give the assurance that Breidenbach had access to Anton Schwarzkopf's expertise. Item 10 of the contract (Ex. 4), the first warranty of the seller provided that Mr. Schwarzkopf, Sr. would be responsible for the layout and the design of the coaster system.

Keur knew something of Anton Schwarzkopf's reputation, but nothing about Breidenbach, whose company was getting the contract. An amendment was added on page 2 of the contract (Ex. 4) as follows:

> "The purchaser requires and the seller agrees that all services under this contract will be carried out under the direct supervision of Mr. Schwarzkopf, Sr.".

Keur testified:

> "That was my request, what I asked Mr. Mooney to put in the contract, that Mr. Schwarzkopf at all times was in charge of building the coaster." (231)

Mooney testified further:

> "We were aware that *Mr. Breittenbach (sic)* had control of the Schwarzkopf company, and we wanted to ensure that the person whose reputation that we were going on, that the Mr. Schwarzkopf [who] had built all the rides and designed the most rides in the world, and

> had the highest quality, that Mr. Schwarzkopf, himself, would be there at all times to make sure that we received our ride and that he wouldn't become out of the contract after we signed it". (59)

Mr. Mooney was asked why the contract required that Anton Schwarzkopf be involved and responded:

> "It was the presence of Mr. Schwarzkopf that we felt was the person with the family experience that would give us the design we wanted, and we wanted to be assured of quality control." (185)

Mr. Mooney further testified:

> "I believe that Mr. Schwarzkopf was involved to do the design of the ride itself, similar to the analogy I used as an architect doing the architectural work. And after that, it was up to the factory to build it." (188)

A roller coaster built for portable use in Germany requires inspection and acceptance by an independent German testing agency, Technischer Uberwachungs-Verein Bayen (TUV). A roller coaster built as a fixed installation will be under the control of local German authorities, although TUV is often engaged by local authorities to carry out the inspection (5977). In a coaster being manufactured for export, whether such inspections as those provided by TUV are done is at the option of the purchaser. Mooney testified that he understood TUV testing "was not part of the requirements for an exported ride" (72). It was his understanding that TUV was a regulatory body similar to the Elevators and Fixed Conveyances Branch in Alberta, although he now understands it is a testing agency that tests mechanical equipment (72). Triple Five chose to remove the cost of the TUV testing, approximately $70,000.00, from the supply contract (Ex.4, p.8).

There is no Canadian equivalent to the TUV inspection, so Triple Five gave up an opportunity of an experienced, qualified and independent inspection by TUV of the product being manufactured. If a manufacturer knows that TUV will be inspecting, it might be less likely to permit any departure from TUV standards. For example, cast steel is prohibited in certain applications under TUV rules, and Schwarzkopf GmbH used this material in the Triple Five coaster, but did not use it in the Bruch coaster which was subject to TUV inspection (5073).

Triple Five was requested to make advance payments of $3,000,000 to finance manufacturing. Triple Five was also advised that the Breidenbach companies would have no liability for the debts and obligations of the new company, Schwarzkopf GmbH, unless this was provided for by contract (Ex. 247).

The contract to build the Triple Five coaster was signed on 29 November, 1984 (Ex. 4). This was about six months after the new company, Schwarzkopf GmbH, had acquired the machinery of the bankrupt company that had been owned and operated by Anton Schwarzkopf.

On the 30th of November, 1984, as security for the performance of this contract by the new company:

(a) The other four Breidenbach companies executed and delivered their guarantees (Ex. 244); and

(b) Marianne Becker gave a land charge on her interest as Purchaser in the plant and plant site, and her husband and Breidenbach signed the land charge on their interest as Vendors under the Agreement for Sale to her (Ex. 245). (The land charge in favour of Triple Five was subject to the prior claims of a German bank, so there was little equity remaining to secure Triple Five); and

(c) The new company signed a chattel mortgage in favour of Triple Five of machinery, equipment and the materials and parts to be purchased from suppliers for the manufacture of the coaster (Ex. 246). (Triple Five's German solicitors advised Triple Five not to sign this chattel mortgage because this could possibly result in Triple Five becoming liable for the debts and obligations of the new company, Schwarzkopf GmbH (Ex. 243).)

Mooney took these securities because of his concern about the financial ability of the Schwarzkopf GmbH company to complete the ride (84). These securities obtained by Triple Five gave some assurance for the monies they had to pay in advance. Under the supply contract, thirty-three percent of the price, amounting to $1,518,000, was payable when the contract was signed in November, 1984. This was available to the new company to fund its manufacturing (Ex. 4). When those funds were used up, a further thirty-three percent was paid on the 6th or 7th of March, 1985 (90). Coincidentally, Keur was in Germany at the time the second instalment under the contract was requested. He toured the factory and advised Mooney that the ride was sufficiently complete to release the second payment (87-8).

Viebahn, the plant manager in Muensterhausen, testified that the situation he found at the plant was abnormal (4285). The company for which he now worked was taking over the business of a previous company which had gone bankrupt (4285). The suppliers who manufactured most of the mechanical parts of the coaster did not trust the company, and "we had to make a lot of negotiations with them to get them going for making good parts for us" (4285). Viebahn was unhappy with the equipment in the plant, and stated "all the equipment what was established there in the plant was real old stuff. There was no new machinery" (4292). It was Viebahn's opinion that money should be invested in new machinery so that the plant could manufacture better products, and in a more economical way. However, Breidenbach built a new office building containing a lot of office space which was not used (118) (4293). This was at a time when suppliers to the Schwarzkopf GmbH plant were not being paid. The head office of the Breidenbach companies in Keurten also failed to pay the government for health insurance and social security in respect of the employees at the Schwarzkopf GmbH plant for the months of April, May and June of 1985 (4295).

Viebahn also testified that when Becker personally needed some money for a lease deposit, he took a substantial sum out of the Breidenbach companies (4297).

In June, 1985, just prior to bankruptcy, Viebahn came to Edmonton to request payment of the third instalment under the supply contract (88) (4296) (4303) (5210). This amounted to $920,000, being twenty percent of the total purchase price, and it was payable when the value of portions of the ride shipped was equal to twenty percent of the total.

Triple Five was somewhat skeptical of the validity of this claim, made so soon after the previous payment, and considered it necessary to have Mooney go to Germany to satisfy himself as to what had been shipped, what remained to be completed, and what bills were paid or unpaid (88-9) (5211).

Mooney discovered that Schwarzkopf GmbH was not paying its bills and did not have the funds to complete the ride (89) (94) (Ex. 249) (4296) (4304). In meetings with Breidenbach, Becker and their controller, Carmele, he learned that funds had been transferred from Schwarzkopf GmbH to pay debts and liabilities of other Breidenbach companies, and if one went into receivership, all would go into receivership, which in fact happened (5216) (5217).

Mooney was advised, in meetings with Breidenbach and Viebahn, that the creditors of the company were threatening receivership and that the company could not assure completion of the roller coaster unless Triple Five agreed to pay $2,000,000 more than the original contract price (94-5). Mooney obtained legal advice that any payments made by Triple Five with knowledge of the claims of unpaid creditors could be attached by those creditors (5213-4). Mooney therefore refused to make payment and stayed in Germany until the Receiver was appointed (95). He hired lawyers in Germany to represent Triple Five's legal interests in the receivership (96). He did not meet with Schwarzkopf (98-9). The contract provided that the purchaser shall be responsible for making available the services of an engineer at his expense, representing the interests of Triple Five in the performance of the contract and that all additional costs which are incurred upon instruction of the engineer shall be borne by the Purchaser (Ex. 4, p.6,7,8). Triple Five did not hire an engineer to represent its interests in the performance of the contract.

With respect to the management of the company, Mooney found that Messrs. Breidenbach and Becker did not appear to be on friendly terms and he was getting contradictory stories and explanations from each of them (5218).

Viebahn testified that Becker and Carmele had called a Board Meeting on May 6th, 1985, at which they outnumbered Breidenbach 2-to-1, and they had voted him out of office as President or Business Manager (4287) (4297) (Ex. 289). Carmele continued as sole President or Business Manager (4297-8).

There had also been differences and disagreements between Breidenbach and Anton Schwarzkopf. When the Anton Schwarzkopf family company had gone bankrupt, there were disagreements and broken relations as to who was to blame (4289). As a consequence, Anton Schwarzkopf had some friends in the plant, but he also had some enemies as well (4299). Breidenbach had retained Schwarzkopf as his personal consultant because, having regard to Schwarzkopf's reputation in the amusement ride business, no other choice was possible (4289-90). There were disagreements between the two which Viebahn described as "love-hate" (4290). Viebahn testified that Anton Schwarzkopf was not at the plant on a regular basis "due to the special problems he had with everyone and everyone had with him" (4301) (4288-9).

The evidence before the Board was that Bachschmidt was responsible in the plant for the construction of the roller coaster track and that Anton Schwarzkopf was responsible for the design of the trains. Viebahn testified that Schwarzkopf and Bachschmidt also did not get along together. He described their relationship as being similar to putting two geese in one box and after five minutes neither would have a feather anymore (4378). Viebahn testified that Breidenbach delegated to him the political problem of maintaining peace in the plant by keeping conflicting personalities apart. Notwithstanding the provision in the contract that all services under the contract would be carried out under the direct supervision of Schwarzkopf, Viebahn testified that Schwarzkopf was primarily employed outside the plant in coordinating the services of the consultants involved in the design of the trains. When he came to the plant, it was to see Klein in Plant No.1. Klein, who was a friend of Anton Schwarzkopf, was the supervisor in charge of assembling the trains. Ordinarily, Schwarzkopf did not go to Plant No.2 where the track was being constructed, or to the office building (4299-301) (4371-2) (4377-8). When the design was complete, presumably Schwarzkopf would have been available under the contract to supervise construction of the trains.

The financing and accounting for the Breidenbach group of companies was done centrally, at Keurten near Cologne. Triple Five's deposits in excess of $3,000,000, which were intended to fund the manufacture of the coaster, were used in part for other purposes of the Breidenbach companies (5216). Viebahn testified that the first two payments did not get to Muensterhausen at all, and that the Schwarzkopf GmbH plant "didn't see a nickel of it" (4285-6). Viebahn stated that the suppliers who manufactured mechanical parts for the ride did not trust the plant and it took considerable negotiation to persuade them to undertake the work (4285).

By June 1985, Schwarzkopf GmbH was in serious financial trouble. Although the trains had not yet been manufactured, the design for the trains to be used in the Triple Five coaster was being completed by Anton Schwarzkopf in collaboration with two consulting engineering firms, the Werner Stengel firm and the IMA firm. Each of the three parties performed a different role in the design process. Each of these three parties had been pressing Schwarzkopf GmbH for payment of their unpaid fees.

Abele of IMA testified that IMA had continuous problems in obtaining payment by Schwarzkopf GmbH (4649). The monies that were received only came after long delays and a lot of pressuring. Only when IMA refused to deliver further production drawings until they received some money would they then get a payment on account (4650). The Stengel firm, whose role was to do the engineering calculations and to approve the production drawings done by the IMA firm, had similar problems with payment. On at least three occasions, Stengel had refused to do further work unless some payment was made on account (4986-9). Stengel testified that Anton Schwarzkopf had similar problems in obtaining payment of the monies owing to him (4987). A number of suppliers had lien claims against materials supplied for manufacture of the roller coaster.

Accordingly, the new company Schwarzkopf GmbH was unable to fund the manufacturing and to pay its suppliers and subcontractors, and it became bankrupt approximately seven months after it had signed its supply contract with Triple Five and one year after it had acquired the machinery of the former bankrupt company owned by Anton Schwarzkopf.

The first Receiver of Schwarzkopf GmbH, the second bankrupt company, was Schaffler, appointed on June 25th, 1985 (4294-5). The other Breidenbach companies had given guarantees, but they were also all in receivership (5216). In these circumstances there were doubts whether the Receiver could continue to operate the plant until the manufacture of the Triple Five coaster was completed. Mooney testified as to his concern as follows:

> "Q. After arriving in Germany in June of 1985, Mr. Mooney, and after ascertaining that Mr. Schaffler had been appointed receiver, did you satisfy yourself that Mr. Schaffler and the company Schwarzkopf would be able to complete the roller coaster?
>
> A. It was a very difficult -- that's a very difficult question. Was I at any time totally convinced? I would have to say no, but there was no other ball game. The ride was 30% shipped and 60% percent under construction and I had no choice but to bear it out with the people that were building it." (135)

The claims of unpaid suppliers and subcontractors had to be settled before the coaster could be completed or exported. Mooney was warned by Triple Five not to incur costs in excess of the original contract as there were no surplus funds in the budget (Ex. 250), and Mooney testified that he knew Triple Five had no surplus funds for cost overruns in the manufacture of the ride (5219).

The Receiver of the bankrupt Schwarzkopf GmbH had no funds to finance the remainder of the coaster; therefore construction stopped.

Prior to the bankruptcy, approximately twenty percent of the coaster had been shipped. This consisted mainly of track and structure. The remainder of the track and structure was largely fabricated and on hand at the plant (134) (100). A relatively small amount of finishing labour was required to complete the track and structure, including temporary erection and dismantling to check that adjoining parts fit, welding tracks, grinding track joints, sandblasting and painting.

About a week after the appointment of the Receiver, Triple Five and the Receiver entered into an Agreement dated the 2nd of July, 1985 (Ex. 11). It is referred to as the Track Agreement, and it provided for completion of the track and the structure. A firm price of 300,000 German marks was stipulated, covering labour, supplies and technical personnel. The price was payable in six approximately equal instalments of 50,000 German marks, the first of which was to finance immediate start-up. Each subsequent instalment was to be paid only upon proof of production progress and transfer of ownership of all parts produced to Triple Five. All rights of the Receiver under his contracts with subcontractors were relinquished to Triple Five (99-100).

Completion of the track and structure having been arranged for, the principal portion of the original contract remaining to be performed was manufacture of the six trains.

As more particularly described in Part V of this Report dealing with Design, Item 10 of the original contract provided that Mr. Anton Schwarzkopf, Sr. would be responsible for the layout and the design of the coaster system. In the months immediately preceding the bankruptcy, Anton Schwarzkopf had been actively engaged in coordinating the design services of the Stengel firm and the IMA firm. Because the coaster being designed for Triple Five was going to be subject to forces greater than those present in existing designs to that time and because the ride was to be installed indoors, the three parties engaged in the design process decided that it was advisable to design a new bogie system. Schwarzkopf conceived the new design, IMA was preparing drawings, and Stengel was approving drawings after his static calculations confirmed that components could withstand the forces to which they were going to be subject. The design process required frequent communication among the three participants, each of whom performed a different function and had a different responsibility.

Before the bankruptcy, the nonpayment of professional fees was resulting in periodic withholding of services by one or other of the participants. At the same time there appeared to have been omissions or deficiencies in the design process. Two of the principal participants in the design process, Anton Schwarzkopf and Steininger of the Stengel office, did not testify before the Board, so the evidence before the Board relating to these omissions or deficiencies is not conclusive or complete.

As more particularly described in Part V dealing with Design, plans and drawings were required before the trains could be built. The Receiver bought drawings from IMA, one of the three participants in the design process, which plans were delivered to Mooney and Corsbie. No inquiries were made of Schwarzkopf (who was responsible for the design process) and Stengel (who did the calculations of the forces) as to whether the plans purchased from IMA were final plans, plans that they had approved. The Receiver and Triple Five declined to pay Stengel's account for his services in connection with the design of the coaster because they considered they did not need him any more. In the end, the plans purchased from IMA by the Receiver contained the defects in the design of the vertical axle assembly that was one of the direct causes of the accident.

There were clear advantages in acquiring the track and structure from the Receiver because its manufacture was almost complete prior to the bankruptcy and the cost of the labour to finish it was relatively minor. The same considerations did not apply to the six trains, the design of which was still being worked on just prior to the bankruptcy. Most of the manufacturing of the trains remained to be done and to be paid for.

Mooney requested the bankrupt company to complete the manufacture of the coaster (96-7). Over a period of four and a half months, Triple Five and the Receiver entered into four more contracts relating to the construction of and the financing for the completion of the balance of the ride. As provided in these contracts, Triple Five provided financing to the Receiver under strict terms and conditions which gave Triple Five effective fiscal control over the manufacturing process. The terms of each of these contracts are summarized in the following paragraphs. Triple Five continued to rely on such quality controls as the bankrupt company might already have.

Mooney inquired from the Receiver and Viebahn as to staff arrangements, and testified:

> "We were told that the original workmen and people who run the factory and all the Schwarzkopf people were in place and were totally capable of finishing the ride to the very same standard as had been contracted for." (135-6) (173)

At that time, with respect to Schwarzkopf, Mooney stated:

> "I still was not even cognizant of the fact that he wasn't there doing any inspections. (136)

Mr. Mooney was assured by the Receiver that the quality control and the supervision of the actual construction would continue as before (173).

Triple Five and the Receiver entered into the Manufacturing Agreement dated the 12th of July, 1985 (Ex. 12). It provided that the balance of the ride, other than the track, was to be completed by the Receiver in accordance with the specifications of the original contract of November 29th, 1984 and that the ride was to be completed at the lowest cost and in the shortest time possible. This was a cost-plus contract under which the Receiver was to submit detailed particulars of his labour costs and material costs to Triple Five every two weeks. Triple Five checked and paid these costs plus a fixed percentage, and ownership was transferred to Triple Five immediately on payment (101-2). Shipping of the ride was to become the responsibility of Triple Five (121-2) (5237).

Mooney testified:

> "This agreement allowed us to - - was basically an agreement to have the Receiver continue to keep the factory open and complete our ride. Consideration for that was his total - - his costs, his costs of materials and his cost of labour to complete the ride plus a percentage to cover his overhead and other expenses." (101)

Triple Five and the Receiver entered into a Settlement of Claims Agreement dated the 12th of July, 1985 (Ex. 13). This Agreement dealt with security interests in existence in favour of suppliers for parts supplied or to be procured for completion of the ride. This Agreement provided that all third party liens or claims should be negotiated jointly between the Receiver and Triple Five on the one hand and the supplier on the other, with the goal to reduce such claims as much as possible (Ex. 13, p.3) (103). To settle such claims, Triple Five undertook to deposit an agreed amount in a trust account with its lawyer in Germany. The Receiver and Triple Five were to negotiate jointly with each claimant (114-5). When a claim was approved by both Triple Five and the Receiver, it could be paid out of trust in exchange for release of all security. Upon the settlement of all claims, thirty percent of any balance of Triple Five's funds remaining in the trust account was payable to the Receiver (Ex. 13) (104). Claimants were paid approximately thirty to fifty percent of their original claims (242-4).

The Accounting Agreement between the Receiver and Triple Five was dated the 12th of November, 1985 (Ex. 14). It acknowledged that the Receiver's accounts had been audited by Triple Five. The parties agreed on the costs of manufacturing incurred by the Receiver, including various payables, suppliers invoices, wage costs, and production costs (106-9) (253-6). The Agreement recites a settlement of third party claims for approximately half of the monies agreed to be deposited in trust and provides for payment of thirty percent of the balance of the trust fund to the Receiver (Ex.14) (105-111) (256-8) (5238-42) (Ex. 257).

Finally, Triple Five and the Receiver entered into a Spare Parts Agreement dated the 14th of November, 1985 (Ex. 15). This Agreement provided that the Receiver would order designated spare parts required by Triple Five for the coaster. The Agreement provided for negotiations of price with each supplier and for negotiations for discounts for prompt payment. The Receiver's remuneration was a percentage of the net sum invoiced by the supplier. If the Receiver negotiated discounts or quantity discounts, he received additional remuneration of a percentage of the reductions he negotiated. Delivery of spare parts was to take place by instalments on designated dates (258-9) (5242-3).

Senior executives of Triple Five spent some months in the aggregate in Germany, negotiating settlements of the claims of creditors and working with the Receiver to arrange for the manufacture and delivery of the balance of the coaster. They worked in the Schwarzkopf plant office, where they had ready access to the Receiver, the plant management and the manufacturing facilities where the remaining portions of the coaster were being completed (118). They participated in the financing and fiscal management of the bankrupt company during the majority of the manufacturing process to the extent set out in the terms of the five Agreements with the Receiver.

Marion Corsbie was brought to Germany as Triple Five's representative to watch the Receiver's costs (117). Mooney also remained in Germany for about a month to negotiate with principal creditors and returned again from time to time during 1985 to keep abreast of the situation. Prior to the bankruptcy, the work force at the plant had been about 160 employees, and the Receiver operated with a reduced staff of approximately 100. Both Bachschmidt, the chief designer of the track, and Stein, the plant production manager, remained after the bankruptcy (4303) (4305). Viebahn, the plant manager, testified that, after the bankruptcy, the problems of obtaining parts from the suppliers continued and money had to be paid before the parts were delivered. Viebahn stated that representatives of Triple Five and officials of the plant frequently looked through the invoices to see which supplier had to be paid and who could wait. Only in this way could the work be kept going continuously (4307) (4311).

Mooney testified, however, that Viebahn did not tell him about ongoing problems with suppliers and that he was not aware the plant was paying invoices on a day-to-day basis (5229). He said that he and Corsbie were not involved in determining which invoices were to be paid at what time (5230-1). To such extent as the evidence of Viebahn and Mooney on this issue may differ, the Board accepts the evidence of Mooney. Mooney testified that Corsbie was checking materials and labour going into the ride as per their other contracts. Mooney testified further that:

> "Marion Corsbie was there during this period of time and while the construction was going on, we were trying the best we could to keep track of all of the costs that Schwarzkopf were incurring and all the claims that had to be paid and we had an ongoing - - not a ledger, but an ongoing idea of where we were in trying to keep up to their accounting." (105-6)

Corsbie testified that the Receiver looked to her for approval of accounts, wages, and payments for which Triple Five would ultimately be responsible (269). She reviewed invoices and labour charges to ensure that the Receiver was keeping costs under control (105-6) (5223) (Ex. 253). Mooney testified that ample funds had been deposited in trust with Triple Five's lawyers in Germany and were made available to the bankrupt company to pay for C.O.D. purchases from suppliers (5321). He also testified that during the time he and Corsbie stayed in Germany, they spent most of their time in the office building on the site, but each went out onto the floor of the plant to view the work in progress on the roller coaster (5232-3). Corsbie stated that she was trying to keep track of the number of hours spent by employees of the bankrupt company on the Triple Five roller coaster (245-7). Mooney testified:

> "I did try to make a daily visit to the factory areas. I felt that I wanted the men to know that even - - because they certainly knew the company was in receivership, but I wanted them to know that there was a personal interest of Triple Five in that roller coaster and we were there and caring." (5233)

The original contract between Triple Five and Schwarzkopf GmbH contained provision for the purchaser to appoint an engineer and for the purchaser to do various inspections as set out in the contract (59).

The roller coaster is a complex engineering structure for which the design engineer produced over 6,000 pages of calculations. The manufacturer contemplated that the purchaser would want inspections to be done on its behalf because provisions for such inspections were included in the draft contract submitted to Triple Five by the manufacturer (Ex. 4). In addition to the purchaser's right to appoint an engineer to represent the interests of Triple Five in the performance of the contract, there are further provisions relating to inspection. The goods may be inspected by the purchaser for conformity with the contract specifications before shipment (Ex. 4, p.15). The purchaser has the right to inspect the production, assembly, packing, and performance of the contract, and the costs of its personnel for inspection were to be borne by the purchaser (Ex. 4, p.16).

Triple Five, in looking for a manufacturer for its coaster, intended to select Anton Schwarzkopf and his company. When Triple Five found that this company was bankrupt and had ceased to operate and that the company owned by Breidenbach was endeavoring to replace it, Triple Five provided in its contract with Breidenbach's company:

(a) that Mr. Anton Schwarzkopf, Sr. would be responsible for the layout and the design of the coaster system (Ex.4, p.14); and

(b) that all services under the contract would be carried out under his direct supervision (Ex.4, p.2).

These provisions were intended to ensure that Triple Five would receive the type of quality product for which Anton Schwarzkopf had earned his reputation (59).

In the original company, Anton Schwarzkopf was an owner, officer and manager. In the new company, Schwarzkopf GmbH, owned by Breidenbach and Becker, he was none of these. If the ownership or management of the new company differed with Schwarzkopf, they had the power of decision. Schwarzkopf was not a party to the supply contract and had no right to enforce its provisions. The contract contained no provision for Schwarzkopf to report to Triple Five. The new company in due course appears to have excluded Schwarzkopf from its plant.

Mooney testified on several occasions during the course of the Hearings. He responded to a number of questions relating to the involvement of Anton Schwarzkopf and there were variations in the answers depending on the context. The contract provided that Anton Schwarzkopf would be responsible for two things: firstly, layout and design, and secondly, supervision of all services. The focus of Mooney's evidence was in some cases directed to one of these responsibilities and at other times to the other. The following are a number of references to or quotations from representative portions of Mooney's evidence.

Mooney did not see or speak to Schwarzkopf from July, 1985 to November, 1985 (116). When Triple Five became aware of his absence during the time when Triple Five was financing the Receiver to manufacture its trains, Triple Five took no action to ensure his supervision as provided in the contract.

Neither Mooney nor Corsbie saw Schwarzkopf at the factory between June and October of 1985 (5233) (250-1). Mooney testifed that when he arrived in Germany in June of 1985, he assumed that Schwarzkopf had been involved in the design and manufacture of the roller coaster up to that date, but he did not make any enquiries in order to verify that assumption (132-4). Viebahn testified that, prior to the bankruptcy, Anton Schwarzkopf was in the plant almost daily, discussing the manufacture of the trains with Klein, the supervisor of that aspect of production, but that after the bankruptcy he did not show up anymore (4377). In his evidence, Mooney said:

> "Q. Mr. Mooney, when you arrived in Germany in June of 1985 and the months following that date, did you have discussions with Mr. Viebahn about Mr. Schwarzkopf, and his continuing involvement or lack of involvement in the project?
>
> A. I can't specifically remember asking if Mr. Schwarzkopf had an active involvement in the coaster at that time." (5226)

Mooney also stated:

> "Q. After the Schaffler receivership in June of 1985, did you make any efforts to have Mr. Schwarzkopf reinvolved in a supervisory capacity?
>
> A. No, I did not, Sir." (134)

Mooney testified:

> "Q. Would it be fair to say that Mr. Viebahn did not indicate to you one way or the other whether Mr. Schwarzkopf was continuing to be involved?
>
> A. Let me say that if, in Mr. Viebahn's testimony, that he told the Inquiry that Mr. Schwarzkopf had been told he couldn't come to the factory and that there was some problems he would have deliberately kept that from me or let me put it another way, he certainly did not tell me

that, because I certainly would have been alerted to something wrong, if that was the case. Had I known that, I might have been overly concerned.

Q. Did you, at any time between June and November or December of 1985, realize that Mr. Schwarzkopf was not involved in the project?

A. Yes, I did. I was really thinking in my memory, trying to probe my memory as to your first question about whether I inquired about him, and I recall asking how was Mr. Schwarzkopf -- because I had met him previously -- and how was he or is he around, can I say hello to him, and the answers I remember it was he's fine, he is working off in another area right now, and he is not around right here very often. Something to that effect. So that it was just a casual remark and I thought well, maybe I will see him next week or while I'm here on the visit I will get to say hello. I was never alerted to the fact that he was not welcome at the factory.

Q. Did it ever come to your attention between June and November or December that Mr. Schwarzkopf was not involved or continuing to be involved in any way with the construction of the roller coaster?

A. Somewhere it did, Mr. Kickham, but I can't -- I can't recall a time or a place or a date or even a time frame when it finally came to our attention that Mr. Schwarzkopf wasn't there at the factory, at some point in time in that period. But I believe it was long after the receiver was in place and that I had returned back to Edmonton. ...

Q. ...Was it in 1985, can you tell me?

A. Mr. Kickham, I just told you that I can't put a time frame on it. In 1985, well, of course -- let's see. The ride started operating in December of 1985, and went into receivership in June, so yes, my best guess would be that it would be sometime in that six-month period." (5227-9)

It appears to the Board that when Mooney refers in his evidence to "asking how was Mr. Schwarzkopf...and how was he or is he around..." (5228), Mooney is referring to a conversation that may have taken place just before the bankruptcy, when Schwarzkopf was engaged in coordinating the design process for the trains with Stengel and IMA.

When Mooney went to Germany in June of 1985, he did not meet with Schwarzkopf nor did he know what Schwarzkopf was doing and he did not know whether Schwarzkopf was involved in supervision of manufacture of the coaster (98). During the period from July of 1985 to November of 1985, he did not see or discuss the roller coaster with Schwarzkopf and he did not know whether Schwarzkopf was playing any role during that period of time in supervising the manufacture of the ride (116).

Mooney testified:

> "...Mr. Schwarzkopf was considered by us the expert in the design of a roller coaster, ... and you will remember from the documents that we specifically asked Mr. Schwarzkopf be involved in it all the way through. To us it was - - he is the prime man who had the - - who all the way along had the knowledge of what was supposed to have been manufactured." (3611)

Mooney testified further:

> "...I would put Mr. Schwarzkopf as the - - as the architect of the whole ride. He initially decided what the configuration would look like and initially decided how it would all fit and what the dimensions were ... he would take that design and he would send it to his structural engineer, which was Mr. Stengel, and Mr. Stengel would then determine if he had to change his loops or he had to change his configuration or whatever...." (3611-2)

Mooney testified:

> "Q. Mr. Mooney, your understanding was Mr. Schwarzkopf was doing the sort of basic configuration for the car and then he would take that basic configuration and send it to Abele to do the drawings?
>
> A. Yes, sir, that that's my understanding." (3613)

On 20 November, 1985, Eskandar Ghermezian wrote a letter to PCL Construction which was assembling the coaster in Edmonton, which read:

> "Please have the engineer examine every component of the train and the track and x-ray every wheel and axle to ensure that everything is properly welded and has no cracks. I cannot stress the importance of this matter enough." (Ex. 5)

On 25th November, 1985, PCL replied in part as follows:

> "Your instruction of November 20th, 1985 regarding the roller coaster is unrealistic and cannot be carried out.
>
> I suggest that it is the responsibility of Schwarzkopf to warrant that his equipment meets all structural design and safety standards, and is free from any defects. They must perform inspections during fabrication and you should try to obtain copies of all inspection certificates from Schwarzkopf.
>
> Also, after execution and commissioning of the ride, Schwarzkopf should issue to you a certificate confirming the completion of the ride." (Ex. 6)

Eskander Ghermezian testified that, upon receipt of the PCL letter, he requested Mooney and Keur to get the proper documents and to confirm with the engineers that everything was properly done, but that he did not know if this had been done (27). Mooney testified that he may have read the PCL letter, but as Ghermezian did not give him any specific instructions to do anything about it, he took no further steps (141-4). Keur testified that he had never seen the PCL letter and that Ghermezian had not asked him to follow up on quality control documentation from Schwarzkopf GmbH (232-3).

Triple Five never obtained or tried to obtain the certificates recommended in the PCL letter.

Mooney testified that he never asked Schwarzkopf GmbH to provide Triple Five with inspections done during the fabrication of the ride (144).

The original supply contract entitled Triple Five to appoint an engineer to represent its interest in the performance of the contract. Triple Five did not retain such an engineer (68-9) (138). Dillon is an operations management consultant in the amusement park industry who has had experience in purchasing amusement rides including roller coasters. Dillon testified:

> "Q. ...have you ever known a purchaser to put engineers in a factory to ensure quality control?
>
> A. No, on the contrary, I'd say the majority of the people do not want to do that. Typically, it's not their business to get involved in the manufacturing." (6048)

Dillon further testified:

> "Q. From your experience, Sir, is that a normal situation where a purchaser has or appoints an engineer to be his representative in the performance of this sort of a contract, a manufacturing contract?
>
> A. It is normal for the purchaser to appoint an individual, not necessarily an engineer, but even in this context, I don't think they are meaning an engineer because they are really saying a representative of the purchaser

> representing the interest of Triple Five in the performance of the contract, nothing to do with the technical aspects of the job.
>
> Yes, it is very common place that there is a representative of the purchaser that will at his determination, possibly from time to time make an inspection of the plant to ensure the construction schedule is on track. Typically, time is always a problem to make sure that the product is being manufactured on time, and it is going to be shipped and delivered, ... specifically, it is very very common for the purchaser to name a representative, be it a person within a corporation or it could even be a representative that is a consultant." (6081)

Hinde is a consultant in the amusement industry, who testified:

> "Q. But does a purchaser on occasion go to the factory?
>
> A. It is possible, as far as a visit to see the facility. More than likely, the purchaser, per se, meaning that agent, the purchasing agent, he may not personally go, it may be an engineering group of the purchasing body, let's say, but you know, on occasion, to see the plant itself and to do a progress report, let's say, during the manufacturing of that product. That does happen on occasion, yes.
>
> Q. What about ensuring the standards are being met? To your knowledge, does a purchaser ever do that?
>
> A. No." (5863)

The original supply contract entitled Triple Five, after notice, to inspect production, assembly and packing of parts of the coaster. Before shipment it had the right to inspect for conformity with contract specifications. These rights were not exercised (138). If Schwarzkopf GmbH performed any inspections during manufacture, Mooney did not receive any reports of them (138).

Mooney was asked whether anybody inspected the roller coaster ride or any of its components prior to it leaving Germany and he responded:

> "I inspected it with my eyes. Marion inspected it with her eyes, but we had no third party professional inspection. And I know of no inspections that were done by anyone, and I have no reports to that effect." (139)

Viebahn, the plant manager of Schwarzkopf GmbH, left the employ of this bankrupt company on the 13th of January, 1986 (4312). On the same day, Schaffler, the Receiver of Schwarzkopf GmbH, was arrested on charges of bribery and fraudulent conversion of assets of the bankrupt company.

The indictment against Schaffler alleged that on the 22nd day of August, 1985 he took 50,000 German marks out of the bankruptcy account of Schwarzkopf GmbH and paid it to the court official who had appointed him as Receiver (Ex. 292). These monies were subsequently recovered by the police and returned to Schwarzkopf GmbH.

Schaffler, who had worked as a Receiver in a number of bankruptcies, was convicted and sentenced for bribery and fraudulent conversion of assets in his possession as a Receiver (Ex. 293). This is only relevant to indicate that the Receiver under whose administration the majority of the manufacturing took place was not a man of integrity. There is no evidence that Triple Five either knew or should have known about Schaffler's activities.

Following Schaffler's indictment, Michael Pluta was appointed as Receiver of Schwarzkopf GmbH to replace Schaffler. Mooney testified that he heard a rumour, probably from Marion Corsbie, that Schaffler was in jail (5245-6). Acting on behalf of the bankrupt Schwarzkopf GmbH, Pluta refused to perform the Spare Parts Agreement (Ex. 15) which had been entered into by his predecessor and which was the only portion of the acquisition process which remained to be completed. Pluta advised Marion Corsbie in early 1986 that the Spare Parts Agreement was too favourable to Triple Five and that he as the Receiver would not honour that contract (252).

Pluta wanted more money for the spare parts than had been provided for in the contract with Schaffler (Ex. 258). Mooney testified, referring to a memo from Marion Corsbie (Ex. 258), that Pluta also claimed 73,000 German marks was owed to Schwarzkopf GmbH by Triple Five. Triple Five disputed this claim (5244). Triple Five subsequently obtained the necessary spare parts by contracting directly with individual suppliers (123).

It is to be remembered that German witnesses are outside the jurisdiction of this Board and cannot be compelled to testify before it. While the Board was fortunate in arranging for some of them to testify, there are still many unanswered questions where the evidence is not available, and the Board's conclusions are based on such evidence as is presently before it.

In summary, the details of the evidence relating to acquisition are as follows:

(a) Triple Five conducted a lengthy search for the best manufacturer with the best reputation for the construction of roller coasters.

(b) The manufacturer selected went bankrupt and ceased to exist before negotiations for the contract for the coaster commenced.

(c) The coaster contract was entered into with a new manufacturer, whose financial resources were not very strong, and who appeared to be trying to assume the role and the reputation of the first bankrupt company.

(d) The contract provided that Anton Schwarzkopf would be responsible for the layout and design of the coaster, and that all services under the contract would be carried out under his direct supervision.

(e) The contract provided that the purchaser could appoint an engineer to represent the interests of the purchaser under the contract and that the purchaser had rights of inspection.

(f) The new company also went bankrupt, by reason of misappropriation of its funds, within seven months of signing the coaster contract, and after delivery of about twenty percent of the coaster.

(g) At the time of bankruptcy the manufacture of the track and structure was nearly complete, so Triple Five entered into a contract with the Receiver providing for the labour to finish and deliver the balance of the track and structure.

(h) The Receiver purchased drawings for the trains from one of the three participants in the design process. No inquiries were made of the other two as to whether these were final plans which each of them had approved.

(i) Triple Five entered into four more contracts with the Receiver of the second bankrupt company for the manufacture of its six trains and the balance of its coaster.

(j) The manufacturing by the Receiver was financed by Triple Five under strict financial controls administered by Triple Five executives in the German plant.

(k) The manufacturing of the trains was not carried out under the supervision of Anton Schwarzkopf.

(l) Triple Five did not retain an engineer or technical consultants to check specifications and conduct inspections, and did not obtain any inspection reports from the manufacturer.

(m) After completion of four of the five contracts, the first Receiver of the second bankrupt company was replaced by a second Receiver of that bankrupt company. This second Receiver refused to complete the fifth contract entered into by his predecessor.

(n) Triple Five then contracted with outside suppliers for the parts covered by the fifth contract.

ISSUES CONSIDERED

As outlined in Part VI dealing with Manufacturing, the trains as manufactured had several manufacturing defects. With a view to determining whether the acquisition process as described in this Part IV had a bearing on the fact that there were manufacturing defects, the Board first gave consideration to the following four questions:

1. In the amusement ride industry, what responsibility for quality does a purchaser normally assume?
2. Are there any circumstances in which a purchaser may have some responsibility to intervene in order to ensure delivery of a quality product?
3. Should the circumstances of the acquisition of this coaster have aroused concerns in Triple Five about the quality of the product that might be obtained and did this place an onus on Triple Five to take any steps to ensure that it received a quality product?
4. Was there adequate quality control at the plant during manufacture?

Question One

In the amusement ride industry, what responsibility for quality does a purchaser normally assume?

Two witnesses who have experience in the amusement ride industry testified before the Board. In addition, an employee of TUV was asked for his observations in this area.

John Hinde is a consultant with considerable experience in the amusement ride industry. He testified that, in his experience, the manufacturer and designer have the obligation of ensuring the proper creation of the product, and that the purchaser chooses the manufacturer and relies on the manufacturer to provide the product. A purchaser does not ensure that the standards are being met, and the manufacturing plant has the obligation for ensuring quality control. He testified that it would be difficult to find an engineer or consultant who would be qualified to do quality control in a manufacturing plant of an amusement roller coaster (5862-4).

Frank Dillon is an operations management consultant in the amusement park industry with 15 years experience (6038). He has been involved in the acquisition of roller coasters in Houston, Texas (6041), in Canada Wonderland near Toronto (6042), and for Expo '86 in Vancouver (6043). He testified that the corporate purchasers he worked for did not put engineers in a factory to ensure quality control and did not want to do that (6048).

Peter Leutenstorfer is an engineer in the employ of the German inspection agency, TUV. His testimony was that the manufacturer has to do its own quality control because it is responsible for its product and nobody else can do quality control for it (5961). He said he had never heard of an instance where a purchaser attempted to ensure quality control.

Based on this evidence, the Board is prepared to accept that in the amusement ride industry it is the standard that a purchaser normally does not assume any responsibility for the quality of the product.

Question Two

Are there any circumstances in which a purchaser may have some responsibility to intervene in order to ensure delivery of a quality product?

Hinde testified that on occasion a purchaser may send engineers to see the plant and to do a progress report during manufacturing of the product (5863). He further stated that a purchaser might have engineers attend a factory to check the progress of construction and manufacturing of equipment their company was purchasing (5873). Hinde testified that he would not inquire into the financial circumstances of a proposed manufacturer unless these circumstances might have an effect on the capabilities of the manufacturer during the time of manufacture or unless the manufacturer was unable to complete the project or to produce the item (5884). Hinde had never experienced the problem of a manufacturer becoming bankrupt during the course of construction of an amusement ride. However, given such circumstances, he responded that he would inquire into the ability of the bankrupt to complete the ride in a quality fashion. He thought he would have to evaluate the information at that time and, based on that information, put together the steps needed to ensure that quality. He indicated he would have concerns if he learned that the owners and senior management were not getting along very well, if he found that funds had been misappropriated, and if he found that suppliers had not been paid. In any of these circumstances, he said that he would like to consider his alternatives (5897-9).

Hinde testified that if the purchaser's contract provided for supervision by Anton Schwarzkopf, he would be concerned whether or not Schwarzkopf continued in that role, he would make inquiries as to his involvement, and he would be concerned if Schwarzkopf was not involved (5906). In the opinion of the Board, Hinde appears to be acknowledging that circumstances could arise in which a purchaser would no longer be entitled to rely entirely upon the manufacturer to ensure the production of a quality product and in which the purchaser should take some action. In such circumstances, Hinde testified that the purchaser might have to investigate and negotiate. Hinde said that he would require the Receiver to show how he could complete the ride. Hinde would be concerned to make sure that financing was in place to complete the ride, who was going to do the completion, and who was going to be in charge at the plant. He would consider making more plant visits, and he would want to make sure that the person in charge of the supervision was still involved in the supervision (5911-4).

Dillon was asked whether a prudent purchaser dealing with a bankrupt company should become involved in the quality control system. He gave a qualified answer, "not necessarily" (6061).

Dillon was in charge of acquiring a roller coaster for Expo '86. The original contract was with an American corporation which had patent rights on the design (6045) (6047). A Dutch firm was licenced by the American corporation to build and sell identical coasters in Europe (6046). When the American company became bankrupt, Expo '86 terminated their contract and entered into a contract with the Dutch company for the identical type of roller coaster (6078). The Dutch company provided Expo '86 with an irrevocable letter of credit issued by a Bank which assured Expo '86 that the terms and conditions of its contract with the Dutch company would be met and provided stiff penalties if they were not (6062). The American company became a subcontractor to the Dutch company for some aspects of design and manufacture following assurances to Expo '86 that the engineering team that had done the design was still intact (6046-7-8). The performance of the entire contract was the responsibility of the Dutch company. In the circumstances in which Expo '86 as a purchaser found itself, it terminated the contract with the manufacturer it had originally chosen and it substituted a new contract which was effectively secured and was with a solvent manufacturer on whom it could rely.

The Board concludes that there may be unusual circumstances where the purchaser has the responsibility to intervene to ensure delivery of a quality product.

Question Three

Should the circumstances of the acquisition of this coaster have aroused concerns in Triple Five about the quality of the product that might be obtained and did this place an onus on Triple Five to take any steps to ensure that it received a quality product?

In the absence of any unusual circumstances, the industry standard appears to be that the purchaser selects a manufacturer and relies on the manufacturer to deliver a quality product.

The circumstances of this acquisition appear to have been unusual right from the start. The purchaser's inquiries had identified Anton Schwarzkopf's company as the one from which they wished to purchase. When they attempted to do so, they discovered that it had ceased to exist and a new company was trying to assume the business and the reputation of the company selected by the purchaser. Mooney had concerns about the financial ability of this new company to perform the proposed contract and so Triple Five took the precaution of obtaining financial security from the manufacturer. Also, Triple Five apparently decided that it did not wish to rely entirely on the expertise of this manufacturer for delivery of a quality product. The purchaser decided it wanted the additional comfort and assurance that all services would be under the personal supervision of Anton Schwarzkopf, whom the purchaser had previously selected, and who had decades of experience in manufacturing quality rides.

Hinde testified that he had never been involved in the purchase of a ride where the purchaser requested and obtained from the manufacturer security for performance in the form of guarantees from other companies, or mortgages (5885). Hinde also testified that in his experience in purchasing rides he had never been involved in a situation in which the purchaser required that a particular person would be in charge of supervision (5888). These provisions were unusual in a purchase contract.

Dillon also was asked whether it was a common in a purchase contract to have a provision requiring supervision by a specific person. It was not common in his experience (6082).

Following the signing of this contract, the purchaser may have been entitled to rely on the manufacturer pursuant to the terms of this contract to produce a quality product in accordance with the industry standard. The contract contained the important provision that the coaster was to be built under the supervision of Anton Schwarzkopf, the principal of the company with which Triple Five had intended to contract for the supply of the coaster, and also it contained a clause which permitted an engineer to represent the interests of Triple Five in the performance of the contract, and it provided for inspections by Triple Five.

However, when the purchaser learned that the manufacturer had misappropriated funds paid by the purchaser, that suppliers and subcontractors were not being paid, that there was dissension between the owners and between owners and management and that the manufacturer was facing bankruptcy, (5215-8) then the purchaser should have been alerted to the possibility that he might no longer be able to rely upon the manufacturer to produce a quality product. The purchaser was a relative novice in the amusement park industry and the circumstances were sufficiently serious to require the purchaser to take specific steps to ensure the production of a quality product. An examination of the original contract discloses some steps that could be taken. The provision that all services under this contract were to be carried out under the direct supervision of Anton Schwarzkopf could have been implemented. Triple Five could have appointed an engineer to represent its interests in the performance of the contract. Triple Five had the right to have the goods inspected for conformity with the contract specifications before shipment. Triple Five had the right to have a person authorized by it inspect the production, assembly, packing, and performance of the contract. Based on Mooney's evidence, the Board concludes that none of these rights were exercised.

Triple Five knew that the bankrupt company did not have the funds to finance the manufacturing because Triple Five had to advance the funds, which led to the fiscal controls. If a purchaser is dealing with a solvent manufacturer who could provide valuable security and against whom there would be continuing recourse, he can safely rely on the manufacturer's warranties as to a quality product, and there is no need for the purchaser to become involved in quality controls. In dealing with a Receiver, not much value can be placed on any warranty of a bankrupt company which is being wound up because its liabilities exceed its assets. As there is unlikely to be continuing recourse against a bankrupt company that manufactures a defective product, there is a greater need for the purchaser to satisfy himself that the bankrupt company is capable of manufacturing a quality product. A purchaser who assumes the risk of having a product manufactured by a bankrupt company should require a greater degree of assurance respecting the company's procedures for supervision, inspection and quality control than would be the case in an ordinary contract between purchaser and manufacturer. The circumstances of acquisition from this bankrupt company should have aroused concerns in Triple Five about the quality of the product that might be obtained. If the manufacturing by this company prior to the bankruptcy required the supervision of Anton Schwarzkopf, it appears that the need for such supervision after the bankruptcy would be increased rather than diminished. In the circumstances, there was an onus on Triple Five to take any steps it could to ensure that it received a quality product.

Werner Stengel is a consulting engineer in Germany who did the design calculations for this roller coaster and who gave Keur advice recommending this manufacturer. Triple Five did not seek advice or assistance from Stengel. The Board has reviewed Mooney's evidence and concludes that persons capable of inspecting for conformity with contract specifications were not consulted or employed; that no effort was made to consult with or employ persons capable of inspecting the production, assembly, packing, and performance of the contract; and that Triple Five did not seek the advice or assistance of persons with technical skills or persons with expertise in manufacturing or quality control. It proceeded to cope with the problem on its own.

Triple Five decided to contract with the Receiver for the manufacture of its trains. Under its contracts with the Receiver, Triple Five exercised an unusual measure of fiscal control over the manufacturing by the Receiver, which is not normal in the ordinary contract between purchaser and manufacturer. Triple Five provided the financing required to enable manufacturing to proceed, participated in negotiations respecting claims of creditors and suppliers, and monitored work done and arrangements for delivery of the trains and their components free of encumbrances. Executives of Triple Five occupied office space in the factory in Germany where they were in communication with the Receiver and the factory management on a day-to-day basis while the trains were being manufactured.

It would have been prudent for the executives of Triple Five who were at the plant and familiar with many of its problems to retain expert advice and inspection services to assist them in ensuring that the manufacture of the coaster they were financing and purchasing met the specifications and quality standards required.

Evidence was given at various times throughout the Public Hearings to the effect that the manufacture of a roller coaster is such an unusual item that specialists who could deal with the technical problems cannot be readily obtained. For example, Hinde, who has no technical training himself, testified:

> "Q. Can't a purchaser go and check around the world who are the right people to check in and to ensure that there is quality control in a plant?
>
> A. I don't believe that there is that engineering firm that has the capabilities to do quality control of a manufacturing plant is available at this time, you know, just to be in a plant to do a quality control." (5863)

While the Board agrees with the premise that the design of a roller coaster might be considered to be a specialized area of technical activity, the implementation of that design, that is the manufacture and assembly of the parts, is not unlike that which would be done in many areas of manufacturing. The production of trunnions and bushings, the selection of bearings, the selection and installation of fasteners, the application of thread adhesive, and so on, are not uniquely related to the manufacture of a roller coaster. For instance, notwithstanding that the trunnions and bushings came from a roller coaster, the experts Beesley and Anderson were capable of performing their measurements.

In the opinion of the Board:

(a) The circumstances of the acquisition of this coaster should have aroused concerns in Triple Five about the quality of the product that might be obtained; and

(b) These circumstances placed an onus on Triple Five to take such steps as it could to ensure that it received a quality product.

Question Four

Was there adequate quality control at the plant during manufacture of the roller coaster?

As discussed in Part VI, Manufacturing, the trains as manufactured contained several defects. In summary, those defects include:

(a) Trunnions machined too small;

(b) The uneven distribution of thread adhesive on the cap screws, indicating improper application;

(c) The items referred to in the TUV Report which generally indicated a lack of conformance with the drawings and items of unsatisfactory workmanship;

(d) The use of grade 12.9 galvanized fasteners;

(e) The missing parts in the wheel structure holding the side and bottom bogie wheels.

In the opinion of the Board, all of these items are clear evidence of the lack of effective quality control in the Schwarzkopf GmbH factory during manufacture of the trains.

The Board also heard evidence from a number of witnesses with respect to a decline in manufacturing standards at the factory.

Stengel testified about a handwritten memo which he had prepared in August of 1985 (Ex. 240) (5072-3). German regulations do not allow the use of cast iron in circumstances where parts were welded and under dynamic load. Stein, the production manager in the Schwarzkopf plant, made repeated requests of Stengel to substitute cast iron parts, "because a cast iron part is much cheaper than the steel part manufactured from a block" (5072). Stengel testified that he told Stein "I forbid you to use a cast iron part" (5073), only to learn later that cast iron was used in the triple loop roller coaster for Triple Five. Stein's explanation to Stengel was that the factory followed a parts list prepared by IMA (5074). During his testimony, Klarl of IMA stated that his firm prepared parts lists, specifying materials to be used, which accompanied production drawings. Klarl identified an IMA parts list for the triple loop roller coaster which specified the use of cast iron for a part in the coupling (Ex. 206) (4630-2).

Klarl also testified that he went to the factory at Stein's request for a meeting to consider changes in specifications and substitutions of materials. One item discussed related to the bogie wheel assembly. The material specified for the steel ring around the bronze bushing in the vertical axle assembly was a very hard steel which was difficult to work with. As it takes much more time to work, this increased the cost. Stein proposed a change in this material but Klarl refused the change because he had received instructions to use this specific material from Stengel and would not authorize a change without Stengel's authority (4602-3).

Because Anton Schwarzkopf declined the Board's invitation to appear at the Public Hearings, there is no direct evidence from him. However, he was in Edmonton immediately following the accident and Sergeant Michael Strulick of the Edmonton City Police testified about a conversation he had with Schwarzkopf. Strulick testified that Schwarzkopf stated he was forced out of the company because he was too accurate or too finicky about work being performed, and that this was not in the best interest of the company. He has no connection with the company which bears his name (3666). Strulick stated Schwarzkopf wished to ensure quality control on the products that he was responsible for manufacturing and that was the reason he gave for being removed (3702). Strulick's further testimony was, in part, as follows:

> "Q. With respect to that discussion on the 15th, did you ascertain that Mr. Schwarzkopf was the type of individual who generally wished to ensure quality control on the products that he was responsible for manufacturing?
>
> A. Yes. As I mentioned before on questioning by commission counsel, that was the reason he gave me personally for him being removed from the company.
>
> Q. The fact that he might want to ensure quality control to an unusual measure?
>
> A. Yes." (3072)

Stengel testified that Anton Schwarzkopf gave him a document which indicated that after Schwarzkopf was out of the company, the company was substituting lower quality materials which were cheaper, for specified higher quality materials, which were more expensive (5068-9).

Stengel also testified as to the discussions he had with Anton Schwarzkopf regarding the latter's opinion of Stein. He reported as follows:

> "Q. Is it fair to say in your discussions with Mr. Schwarzkopf he does not respect Mr. Stein?
>
> A. That's absolute true.
>
> Q. And is it fair to say that he believes Mr. Stein does not exercise proper controls in the factory?
>
> A. That's true." (5185)

Klarl testified that he did not consider Stein to be the perfectionist that Schwarzkopf was, and that Stein was more interested in getting out a product as cheaply as possible and as quickly as possible (4608).

Abele, also with the IMA engineering firm, testified about a request by Stein for the exchange of high quality material for a slightly inferior material, and stated he believed Stein was trying to cut costs (4550).

Stengel also testified relating to a conversation he had with Klein, who was working in the factory when the Triple Five roller coaster cars were being fabricated. Klein indicated that Stein did not have the same perfectionist procedures as Schwarzkopf and that the quality standards were not the same as Schwarzkopf ensured while he was there (5170-1).

After the bankruptcy of Schwarzkopf GmbH, its Receivers also built a roller coaster for Bruch in Germany, which was completed after the Triple Five roller coaster. Stengel testified about complaints that he and the TUV agency had received from Bruch. These complaints led Stengel to have the track, as manufactured for Bruch, measured and surveyed so that it could be compared to the design on his computer. He found out that the track as manufactured did not conform to the design specifications and he stated that he had "more indications that the Bruch coaster is - - had been made very quickly and not carefully watched and no quality control and so on" (5182-3).

Stengel testified that he discovered that Schwarzkopf GmbH had made a modification on a train made for Bruch which he had not authorized. They had altered the relative position of the keeper plate screws in the bogie assembly by forty-five degrees. This resulted in a calculated fifteen percent increase in load for one of the screws. Stengel said nobody told him about this change and that "I have no idea what was happened at that time in the Company" (5184). It is clear that changes to the Bruch ride were being made without consultation with the party responsible for the static calculations.

Heavy wear was experienced in a bronze bushing of the lateral guiding wheel of the bogie wheel assembly. Stengel testified about this wear, stating that Schwarzkopf intended to use PAN-Bronze which is a special bronze that is very hard, much harder than what was in fact used. He stated that when the TUV engineer inspected the coaster in Edmonton after the accident, he recommended a change in the bushing to PAN-Bronze (5139). The TUV recommendation that the DU bushings be replaced with PAN-Bronze is item 3.3.(c) on page 4 of the TUV report, Exhibit 213.

The Board accordingly concludes that there was not adequate quality control at the plant during manufacture of the roller coaster.

Conclusions on Issues Considered

Based on the Board's conclusions on the issues considered in these four questions, the Board is of the opinion that in this particular case, the acquisition process had a bearing on the fact that there were manufacturing defects in the trains as built. Following the bankruptcy Triple Five had its hands full with urgent problems of negotiating contracts with the Receiver for completion of the ride, negotiating settlements with suppliers and claimants, and monitoring financing to enable manufacturing of the coaster to continue and to ensure export and delivery. The paramount focus of the Triple Five executives sent to Germany was on problems other than quality control. Upon the bankruptcy, Triple Five recognized a need for fiscal controls, but did not appear to recognize a corresponding need for steps to ensure the production of a quality product. Having regard to all of the circumstances of the acquisition process, including bankruptcy part way through the manufacturing, the Board is critical of Triple Five for not taking the steps available to it to ensure the production of a quality product.

ANTON SCHWARZKOPF

One of the steps Triple Five could have taken that would have helped to ensure that it received a quality product was to require supervision by Anton Schwarzkopf of the construction of the trains being manufactured by the Receiver.

The original contract provided that all services under the contract would be carried out under the direct supervision of Anton Schwarzkopf. Mooney's testimony relating to this provision was that they wanted to ensure that Schwarzkopf, who had built so many rides with such high quality, would be there at all times. On another occasion he testified:

> "...you will remember from the documents that we specifically asked Mr. Schwarzkopf be involved in it all the way through." (3611)

When Mooney started investigating the circumstances leading to the bankruptcy, he spoke to Breidenbach, Becker, Carmele and Viebahn. If so much reliance was being placed on Schwarzkopf, it is surprising that he did not speak to Schwarzkopf.

The Board has carefully considered all of Mooney's evidence relating to Schwarzkopf. It appears clear that although Mooney may have made some casual inquiries relating to the state of health and whereabouts of Schwarzkopf, he made no determined effort to find him or speak to him. Triple Five entered into a new contract with the Receiver for the building of the trains which provided:

> "The specifications of the performances and services as stated in the contract of November 29, 1984, shall become part of this contract." (Ex. 12, p.3)

This indicates the provision for the supervision by Schwarzkopf of all services became part of the new contract with the Receiver.

If Triple Five needed help to ensure the production of a quality product, Anton Schwarzkopf appeared to be the logical choice. Under the original contract he was responsible for the layout and the design of the coaster, and this aspect of his service was nearing completion before the bankruptcy. The trains, which remained to be manufactured, were a prototype which he had conceived, and under the original contract it was intended that the manufacturing should be carried out under his supervision. He had a lifetime of experience in manufacturing amusement rides and a reputation for producing quality products. These circumstances appeared to require that Triple Five should enforce its contract with Schwarzkopf GmbH by insisting that Anton Schwarzkopf fulfill the role intended in the contract.

In the weeks preceding the bankruptcy, the company was administered by Carmele, and after the bankruptcy the company was administered by the Receiver. Viebahn was plant manager under both. Schwarzkopf was not an ordinary employee at the plant, he was a consultant to the company. Schwarzkopf's services appear to have been terminated about the time of the bankruptcy, and necessarily such termination was done by, or with the knowledge and consent of, either Carmele or the Receiver. In either case, Viebahn, as plant manager, who had the responsibility of trying to minimize conflicts between Schwarzkopf and certain plant employees, should have been one of the first to know of such a termination. Viebahn testified:

> "Q. Mr. Viebahn, I understand, though, that just before the bankruptcy or right after the bankruptcy, Mr. Schwarzkopf was told not to come near the plant again and he did not come near the plant after the bankruptcy?
>
> A. It was not told to Mr. Schwarzkopf by myself. I don't know who told that, and I don't know from which point you have this statement." (4403).

Viebahn further testified:

> "Q. It is my information Mr. Viebahn that immediately prior to the bankruptcy that Mr. Schwarzkopf was advised that he should no longer come to the plant. Do you have anything to your knowledge that would indicate that the information I have would be incorrect?
>
> A. I don't have any information on that. Maybe it was overall situation what made that up, but I didn't - - I didn't tell him don't, or something like that, No." (4404)

Viebahn testified further:

> "Q. Did Mr. Anton Schwarzkopf remain involved in the construction of the trains after Mr. Schaffler arrived in June of 1985?
>
> A. I can't give you a definite answer on that.
>
> Q. Was he at the plant site on a regular basis after June of 1985?
>
> A. At the plant - - he never was on a regular basis at the plant due to the special problems he had with everyone and everyone had with him, so that I can't give you definite answer on that." (4301)

Viebahn testified that he got along with Anton Schwarzkopf "as far as I had not to fulfill some - - some special orders from Mr. Breidenbach or from Dr. Carmele." If Triple Five was not receiving information from Viebahn about the whereabouts of Anton Schwarzkkopf, in the opinion of the Board they should have gone directly to Schwarzkopf.

After the bankruptcy all monies payable to the Receiver relating to manufacture of the coaster or relating to the settlements with creditors were monitored by Corsbie who either knew or had the means of knowing whether any monies were being paid to Schwarzkopf. The Board has considered all of the evidence given by Mooney and is of the opinion that the executives of Triple Five either knew or had the means of knowing that Schwarzkopf was not involved in the supervision of the manufacture of the trains. Triple Five did not offer any explanation to the Board for not involving Schwarzkopf in the supervision of the manufacture of the trains.

Several knowledgeable witnesses testified as to their high regard for the abilities of Anton Schwarzkopf. Stengel testified:

> "... his knowledge is better than the knowledge of a lot of engineers, ... I'm always deeply impressed. ... he's a very good man." (4932-3)

Dillon testified that Schwarzkopf is regarded very highly in the industry and was one of the leading people in the industry (6064). Dillon testified that it would be a point of concern to him if he had a contract that Schwarzkopf was to conduct the supervision and Schwarzkopf was no longer there (6065). Hinde testified about Schwarzkopf:

> "He's a very meticulous individual. He gets involved with everything that he puts together at the factory as far as his design and creativity, and he wants things to be right." (5887)

The executives of Triple Five should have been aware that Anton Schwarzkopf was not playing the role in supervision that was provided for in the contract. In Keur's view, had Schwarzkopf's involvement been insisted upon, the manufacturing defects referred to in this Report would not have occurred. On the final day of the Public Hearings in the Fall of 1986, Keur gave the following evidence:

> "Q. And, in your opinion, if Mr. Anton Schwarzkopf had been involved in the fabrication or the manufacturing of the roller coaster, would the accident and the tragedy have occurred, in your opinion?

A. No, it would not have occurred." (5766)

In the opinion of the Board:

(a) Triple Five could have arranged to see Schwarzkopf if it had determined to do so (it located and brought Schwarzkopf to Canada on the day following the accident); and

(b) It should have enforced the provision in the original contract that all services under the contract will be carried out of the direct supervision of Schwarzkopf; and

(c) If the manufacture of the trains by the Receiver had been under the supervision of Schwarzkopf, the quality of the trains would have been better and there would have been fewer defects.

VERTICAL AXLE ASSEMBLY

The Board then gave consideration to the question, "Would any reasonable steps that could have been taken by Triple Five to ensure quality have discovered the flaw in the vertical axle assembly?"

Various witnesses expressed pessimism about the ability of a purchaser to monitor quality control in a manufacturer's factory.

Leutenstorfer was asked about the role of the TUV inspection and responded:

> "During the manufacturing process we are only involved to do the inspection of important parts and to have a look at parts which we have calculated. And so we do some general measurements in order to assure whether the manufactured parts in general accordance to the plan." (5975)

Leutenstorfer inspected the Bruch four loop coaster and testified:

> "Q. Did you examine the vertical axle?
>
> A. The vertical axle as it is here is in a whole assembly, and this assembly is sealed. I saw only this assembly, and we have the drawings about it, and you know, there is a keeper plate and the screws and they are sealed. And so we do not disassemble these things." (5983).

The Board is of the opinion that it is unlikely that a TUV inspection would have discovered the manufacturing defect in the vertical axle assembly.

Hinde indicated that adequate quality control would be a very hard thing to get involved in from a purchasing standpoint (5900). Leutenstorfer had never heard of an instance where a purchaser put an engineer in a factory to ensure quality control. He did not think it was possible for quality control to be done by a purchaser and stated that for every worker you would require a man to stand behind him (5962). Dillon considered that a prudent purchaser should not become involved in the quality control system because that is the manufacturer's responsibility. Hinde and Dillon have no technical qualifications, and have no expertise or experience in manufacturing or in quality control.

Due to the unavailability of witnesses from the plant, the Board does not know which, if any, of the components of the vertical axle assembly were contracted out to other suppliers. If the manufacture of a component part is subcontracted in accordance with certain specifications, what checks are normally made upon delivery to make sure it complies with specifications? How large a sample of the components would be checked? Based on such evidence as it has, the Board assumes the components of the vertical axle assembly were assembled in the Schwarzkopf plant.

As referred to in Part III, Technical Issues, it is clear that the three participants in the design process intended that a tight fit exist between the trunnion and the bushing so that the bushing would not turn on the trunnion.

The manufacturing flaw in the vertical axle assembly which contributed to the accident was that the fit between trunnion and bushing resulted in clearance, and the question is whether any reasonable steps taken by Triple Five to ensure quality could have discovered this.

Anderson was asked whether a properly equipped machine shop could manufacture to the tolerances that were prescribed and he replied "I believe they could. It allows almost a thousandth of an inch between maximum and minimum deviation. So with proper care and so on, they could" (9129). If a manufacturer is capable of manufacturing within specified tolerances, it appears evident that the manufacturer would be capable of measuring the item manufactured to verify that it complies with specifications.

Leutenstorfer considered that quality control is achieved if each individual craftsman or worker in the plant assures himself that his product is within the specifications of the drawings or the design (5997). Where a manufacturer purchases a component from a subcontractor, Leutenstorfer was of the opinion that the subcontractor would have its own quality controls, and that the manufacturer would also check that the part supplied was in accordance with drawings or specifications (5997-8). Leutenstorfer expected that the Schwarzkopf company would have done measurements of the steel trunions to be sure they met specifications (5999). Leutenstorfer did not know what quality controls were in place at the Schwarzkopf plant, but considered that each worker, each foreman, and each reliable person should assure himself that the parts he is working with are in accordance with drawings.

The Board has carefully weighed all of the evidence before it relating to the circumstances of acquisition and has evaluated that evidence in particular with respect to the presence of defects in the trains of the West Edmonton Mall roller coaster. Those defects have been discussed in two parts: the defects that did not have a direct connection to the accident and those defects that did.

With respect to the first category, the Board has concluded that there are a number of defects in the trains of the coaster and that a substantial number of them are of serious concern. These have been detailed and set out in the TUV Report (Ex. 213) and the Board has commented upon them at various locations throughout this Report. Although none of these had a bearing on the accident, they are of serious concern and corrective measures need to be taken before the coaster can be put back into service. (The evidence before the Board is that some corrective steps have been initiated.) It is the opinion of the Board that the acquisition process had a bearing upon the existence of these defects and it criticizes Triple Five for not having taken the steps that were available to it to ensure a higher standard of quality.

Whether or not the steps that Triple Five could have instituted to ensure a higher standard of quality would have had any bearing upon discovery of the defects in the vertical axle assembly is a much more difficult question. In the Board's opinion, there were a number of steps available to Triple Five in these circumstances, including, but not limited to, the steps contained in the original contract. As well, there were a number of procedures by which the clearance problem might have been identified, including direct measurement of components, observations about the fit as the assembly took place, the supervision of Anton Schwarzkopf, and so on. Different steps taken by Triple Five may have resulted in different procedures being implemented in the factory to ensure a higher standard of quality. The Board is unable to determine whether or not any reasonable procedures, on a balance of probabilities, would have identified the critical problem and therefore is unable to determine whether or not the steps Triple Five could have implemented would have had any bearing upon discovery of the defects in the vertical axle assembly.

V. DESIGN

The Triple Five roller coaster was custom-made for West Edmonton Mall. It is higher, faster, and has tighter loops and sharper curves than most coasters previously built. Over 6,000 pages of calculations for forces, stresses, and the geometry were necessary for its design.

Most coasters operate outdoors, but this one was built to be operated indoors in West Edmonton Mall. Because of its higher speeds, sharper turns, greater forces and its indoor location, the wheel assemblies used in previous coasters appeared inadequate, and a completely new axle and bogie assembly was designed for these trains. It had never before been used on any previously built roller coaster. The new axles, designed to enable a smoother ride at higher speeds, also provided a quieter ride for indoor use. It was the failure of this new axle assembly after only 2,134 trips, which was approximately thirty days, that resulted in the accident at West Edmonton Mall (5282).

The contract entered into between Triple Five and Schwarzkopf GmbH for the construction of the roller coaster provided that all services under the contract would be carried out under the direct supervision of Anton Schwarzkopf (Ex. 4, p. 2). One of the services to be provided under the contract was design, and on page 14 of the contract it was stipulated that Anton Schwarzkopf would be responsible for the layout and the design of the coaster system. Mooney gave evidence that it was initially the understanding of Triple Five that Schwarzkopf GmbH was responsible for the design and that Anton Schwarzkopf personally would be the designer (59-61). Mooney indicated that it was not the understanding of Triple Five at the outset that Schwarzkopf GmbH would retain outside consultants, but that upon learning of such involvement later, he was not surprised (61). Mooney was not aware of the involvement of IMA or the firm Werner Stengel

Engineering Office until about the time of the bankruptcy in June, 1985. Because the Triple Five executives dealing with the roller coaster had no particular technical expertise in the areas of structural design or the manufacture of such rides and did not engage the services of any such technical experts, there is no reason to expect that they would have been able to judge to whom the design of this installation should have been entrusted.

It is clear that Schwarzkopf GmbH intended from the beginning that the design of the roller coaster facility would involve the use of outside consultants. Those consultants would include Anton Schwarzkopf, the firm IMA (represented by Klarl and Abele), and the firm Werner Stengel Engineering Office (represented by Werner Stengel and Steininger). Anton Schwarzkopf was acting as a special consultant to the firm Schwarzkopf GmbH, and he had been involved in the negotiations with Triple Five relating to the Purchase Agreement. The Stengel firm and IMA were both contacted in the fall of 1984 relating to their involvement in the design process.

Notwithstanding an interpretation of the contract that says that Anton Schwarzkopf was to do all of the design personally, there is no evidence that he had anything to do with the design of the track for the Triple Five roller coaster. The evidence of Viebahn was that Schwarzkopf was in charge of the design and construction of the trains (4298). The understanding of the Board is that the geometrical design of the track and the analysis of the forces produced by the passage of trains upon the track and the supporting structure was the responsibility of Werner Stengel. Viebahn said that the construction of the track and supporting structure within the Schwarzkopf GmbH plant was the responsibility of Bachschmidt (4298). Viebahn's evidence was that Anton Schwarzkopf and Bachschmidt did not get along and he considered it as part of his function to see that these two gentlemen were kept out of each other's way (4378). The firm IMA did not have any responsibility with respect to the track and supporting structure (4445), and there was no evidence before the Board as to who produced the working drawings that would have been necessary for the production of these items.

With respect to the design of the trains, the evidence disclosed that Anton Schwarzkopf, IMA, the Werner Stengel firm and Schwarzkopf GmbH all played a role.

According to the evidence of Stengel:

> "Mr. Anton Schwartzkopf was a man with the ideas in his head, and he had done sketches and drafts, and he brought this to the office of IMA, and they brought all this to the drawings to make shop drawings and all the drawings for the train and also for the machinery." (4933)

According to this, and other evidence, it was the role of Anton Schwarzkopf to develop conceptual ideas, perhaps do rough calculations and proportioning of sizes, put these ideas into the form of preliminary sketches or drawings, and then to deliver these to the firm IMA for production into preliminary working drawings. Both IMA and Stengel agreed in testimony that after these preliminary drawings had been prepared, those for parts requiring static calculation would be directed to the Stengel firm. The Stengel firm would carry out those static checks, and, if necessary, the IMA firm and Schwarzkopf would review the results of any suggestions made as a consequence of the static check. It is clear that those who worked with Anton Schwarzkopf had a high regard for his engineering ability, although he was not a legally qualified engineer (Stengel, 4932).

There was no evidence before the Board that anyone at the Schwarzkopf GmbH plant (excepting Anton Schwarzkopf) had a direct role in the design of the components of the trains. The Board takes it that the function of those at the plant was one of seeing that the component parts were built, either in-house or supplied by outside subcontractors, in accordance with the completed and approved working drawings.

The evidence of both IMA and Stengel was that Anton Schwarzkopf acted as a liaison between their firms and with Schwarzkopf GmbH. Schwarzkopf would often personally deliver preliminary drawings of the IMA firm to the Stengel firm in order that the necessary calculations could be carried out. In some cases, blueprints would be returned to IMA for changes after they had been checked by the Stengel firm (4476) (5112). In this way, there might be several drawings for the same part, each with the stamp of the Stengel firm on it (5113). IMA expected that Anton Schwarzkopf would see that Stengel's office received copies of the drawings for those parts requiring further static calculations and that Stengel's office would either approve those drawings or comment as to their inadequacy (4472). Abele of IMA testified as follows:

> "Q. ...I'm wondering if you were aware in specific kilogram units how much force was going to be exerted.
>
> A. The forces were well known to us as Mr. Klarl was in continuous contact with Mr. Stengel or with Mr. Steininger, and we knew the exact magnitude of these forces. That was the reason why continuously the blueprints were sent over to the company Stengel to have it examined on a continuous basis if the bolts, the plates, the bearings were sufficient to withstand these forces." (4478)

Stengel described Schwarzkopf as more than a postman in this process (5114). As well, the evidence before the Board is that, in order to reduce costs, it was decided during the preparation of the drawings for the trains to reproduce IMA drawings from IMA originals at the Schwarzkopf plant (4472). It is the impression of the Board that both engineer approved and unapproved drawings were copied in this manner (4476).

It was the evidence of Mr. Klarl of IMA that, although it was desirable to have the approval stamp of Stengel on all of the drawings, in certain circumstances telephone approval would be obtained from Steininger of the Stengel firm with respect to changes to the drawings. Klarl testified as follows:

> "Q. I would like to ask my question once again. Do you agree that it is a very bad engineering practice to obtain such an approval over the telephone?
>
> A. Generally, it is not done in this fashion, but in this case, we had so much delay already that Mr. Schwarzkopf said, look, every day is very important, if you get your okay over the telephone, then go ahead." (4636)

The evidence of Abele on IMA's position was that it was the responsibility of Anton Schwarzkopf to ensure that the plans delivered to him received the approval of the Stengel firm when static calculations were necessary (4477). Abele gave evidence that IMA was not the party to consider the requirements of TUV, and that the Stengel firm had a very detailed knowledge of the TUV requirements (4494-5).

On the matter of approval of drawings, Stengel testified as follows:

> "Q. I suppose that if Mr. Steininger and Mr. Klarl had discussions, most of them would be by telephone?
>
> A. That's correct.
>
> Q. And again, in the number of years and number of projects that your office did some work in conjunction with Abele, would it be unusual for one or other of those people to pick up the telephone and say, you've approved a part, I can't get some other things, what about this possibility?

> A. That's not unusual, but the rules are later on to send a drawing of it. You can discuss on telephone to save time, maybe to save one day or two days, but there is a must to send the changed drawing to us.
>
> I can tell you the reason for that. Normally they build three times of this ride or 10 times, and what shall we do if there is a question by the fifth ride we need an answer for this part, then I have to shook my head and say, I have no idea what changed they, and so we have files with all the changes normal in the cellar, and there are notes changing all, from the second ride change, from the fifth ride change, that's normal.
>
> Q. So, if I can summarize, it wouldn't be unusual for a change and in effect, then, approval of a change to be done by telephone, but the practice would be and could be that a document or a drawing signifying that change make it to your office and the formal stamp and approval be put on it?
>
> A. Also with two copies." (5113)

The initial approach to the design of the trains was that a previously used design would be used for the Triple Five coaster. Klarl gave evidence that Anton Schwarzkopf approached IMA in December, 1984 with some rough drafts involving cars using the old design for the axles. Later, in February of 1985, they were approached by Anton Schwarzkopf with sketches involving a new design (4571). The evidence is that both Schwarzkopf and Stengel were concerned about using the type of car and bogie wheel configurations that had been used successfully on earlier rides. Schwarzkopf's concerns centered around the fact that the Triple Five ride would be operating in an enclosed space and noise levels could potentially be a problem. Stengel's concerns centered around his feeling that the magnitude of the forces produced by the configuration of the new ride required a redesign of the car and bogie wheel arrangement.

As a result of the concerns of Anton Schwarzkopf and Werner Stengel, Schwarzkopf prepared preliminary drawings of a redesigned train. In particular, this new version had a new bogie wheel arrangement and, as a consequence, it also had a somewhat higher center of gravity than the old trains. These preliminary ideas were discussed at a meeting involving Anton Schwarzkopf, Abele, Klarl, Viebahn, Stengel, and Steininger (4448-9) (4576-80) (4934-41). The meeting took place on about March 1, 1985. Viebahn's interest in the development was to ensure that, if the new arrangement was to be used, the completion date of the coaster would not be delayed. At the meeting it was agreed to proceed with the development of the new train.

The design of certain critical components in the bogie wheel assembly, namely the vertical trunnion and its associated supporting bearings, was completed toward the end of May 1985 (4584) (Ex. 204). Prior to the bankruptcy in June of 1985, there were problems with respect to the payment by Schwarzkopf GmbH of the accounts of Anton Schwarzkopf, IMA, and the Stengel firm. Abele indicated that there were continuous problems, and that it got to the point where IMA indicated that no further drawings would be delivered until such time as funds were received (4650). Stengel also gave evidence as to the difficulty in receiving payments. He said that his firm took the position on three occasions prior to the bankruptcy that, unless payment was received, no further work would be done (4989) (5115). Thus, it can be concluded that the design process was going forward under less than ideal circumstances.

Following the decision at the March meeting to proceed with the redesign of the trains, Klarl prepared certain drawings of the vertical axle assembly. A proprietary steel bearing called IKOS was selected for use in this assembly. The drawings were sent for review to the manufacturer of these bearings and Klarl was subsequently advised that the bearings would have to be precompressed into the assembly between the lower keeper plate and the shoulder of the vertical trunnion. In order to accomplish this, a gap was introduced between the keeper plate and the lower end of the vertical trunnion (4581). Such a gap had not been present in the preliminary sketches up to that time.

In May 1985, it became apparent that a sufficient number of IKOS bearings would not be available in time to meet the completion date for the trains. Klarl therefore prepared drawings that contemplated the use of a different type of steel roller bearing. On that particular drawing, dated May 13, 1985 (Ex. 287, no. 14), the keeper plate thickness was shown as 20 mm. Anton Schwarzkopf prepared a drawing of the same date in which another alternate to the IKOS bearing was presented. This was a bronze bushing arrangement, and this was the choice subsequently used in some of the cars of the Triple Five coaster (Ex. 287, no. 15). Some of the evidence before the Board indicated that the bronze bushings were intended to be a temporary arrangement only and that it was expected that IKOS bearings would replace the bronze bushings as they became available (4481) (4549). However, other evidence indicated that either arrangement was acceptable (Ex. 36). Certainly the owner, Triple Five, was never informed that the bronze bushings were to be replaced at some point by the steel IKOS bearings.

Klarl's evidence was that, because of the lower bearing strength of bronze as compared to steel, it was necessary to increase the length of the trunnion. This in turn required a reduction in the thickness of the lower keeper plate in order to maintain clearance between the underside of the keeper plate and the top of the track. The keeper plate thickness is described by Klarl as being reduced at this time from 17 mm to 12 mm (4590). IMA prepared a working drawing (Ex. 185) to show the bronze bushing alternative. Klarl testified as follows:

> "Q. With respect to Exhibit 185, do you know whether that document or drawing was delivered to the Stengel office?

> A. On the 21st of May, 1985, I have given two copies of this drawing to Mr. Schwarzkopf, and Mr. Schwarzkopf directly drove to the Stengel company.
>
> May I add something? What I would like to add really is that a very common occurrence was that Mr. Schwarzkopf came to our office; I gave him some blueprints; he took them over to the Stengel company. A couple of hours later, I received a phone call, and I was told, okay, it has been approved, go ahead.
>
> Q. Do I understand it correctly that you gave two copies of Exhibit 185 to Mr. Schwarzkopf?
>
> A. Yes, that is apparent from this list.
>
> Q. Are you referring to page 3 of Exhibit 203?
>
> A. Yes." (4593)

And later:

> "Q. Did you require the approval of the Stengel company before releasing Exhibit 185 to Schwarzkopf GmbH?
>
> A. Yes, but that very often happened by the telephone.
>
> Q. Specifically with respect to Exhibit 185, did it happen via the telephone?
>
> A. It was either via telephone or maybe it came from Mr. Schwarzkopf. I really cannot say that right now with certainty." (4596)

Stengel testified that his records indicate that the static calculations for the triple loop roller coaster were completed by his firm on May 22 (4949), about a month prior to the bankruptcy. He also stated that he understood the introduction of bronze bushings as an alternate occurred sometime after that date (4983). Stengel's firm did not redo the static calculations in relation to the use of bronze bushings on the three loop roller coaster. Such calculations were done at a later date with respect to the four loop roller coaster which used the same design for the vertical axle assembly (Ex. 230, p. 243-C) (4982-4). It was Stengel's evidence that Steininger did some rough static calculations with respect to the alternative of bronze bushings sometime after March 26, "but Mr. Steininger checked only to transfer the forces about the bearing, not the function and all the other parts, because that was not our duty" (5119). Stengel also stated that the time records kept by his firm, and in particular by Steininger, were not designed to be more than general records and any task less than half an hour in length would not be recorded (5120).

IMA prepared the detail of the vertical axle assembly showing the thinner keeper plate and the gap between the plate and the vertical axle on a drawing dated 22 May, 1985 (Ex. 185). The IMA revised drawing of the keeper plate reducing its thickness was dated 24 May, 1985 (Ex. 172). The final shop drawings for the trains were completed by IMA on the 19th of June, 1985 (Ex. 203). The shop drawing used for manufacturing the vertical axle differed from the "Construction Book" drawing (Ex. 36) prepared by Stengel. The latter was prepared by Stengel for delivery to Triple Five and to the Alberta Department of Labour.

Stengel's evidence was that his firm never received Exhibit 185 (4956-7) and that the first he learned of the use of a gap between the keeper plate and the bottom of the vertical trunnion was on his flight over to Canada on the day following the accident, June 15, 1986. Stengel was in the company of Anton Schwarzkopf and it was at this time that he saw the axle assembly drawing subsequently marked as Exhibit 228 (5033-6) (4956-9). He testified that his firm had not received an IMA drawing disclosing a gap, and stated:

> "...There's a mark on the list of IMA...there is a mark that Mr. Schwarzkopf did get from IMA the original drawings to bring it to the Schwarzkopf company, but they didn't copy it and send it to us.
>
> Maybe these are the two reasons to save the money for the copies and the other reason no contact to Stengel because he is always asking for the 51,000 D-Mark." (5115)

The Board makes no finding of fact as to whether the Stengel firm was or was not aware of the specifics of Exhibit 185 in May of 1985.

Prior to the bankruptcy, there were three participants in the design process for the trains. Anton Schwarzkopf had the responsibility of coordinating the work done by IMA and by Stengel. After the appointment of a Receiver on the 25th of June, 1985, Triple Five negotiated with the Receiver for the purpose of getting the coaster completed and delivered. The Receiver purchased a complete set of drawings of the train from IMA (4548). Abele of IMA testified:

> "Once we -- our drawings were all complete, I did visit the company a couple of times to talk to Mr. Mooney and to talk to Mrs. Marion (Corsbie) and to give them sets of the drawings." (4547)

The purchase of drawings for the trains was from one of the three participants in the design process, namely IMA (4548). By this time, Schwarzkopf had been excluded from the plant and was not seen by Triple Five from June to October of 1985. Mooney testified that he met Stengel when Stengel had come to the factory as a claimant with regard to the non-payment for his design services (116). Stengel was owed 51,000 German marks for his calculations with respect to the triple loop coaster, so in the summer of 1985 he met at the Schwarzkopf GmbH office with the Receiver, Mooney and Corsbie. Stengel testified:

> "The Receiver told me we don't need you, so we don't pay you. And then we had little discussions, maybe Triple Five can pay it. But Michael Mooney told me also we don't need you." (4988)

No inquiries were made of the other two participants in the design process, Schwarzkopf, who was responsible for design under the contract, and Stengel, who calculated the forces, as to whether the plans purchased were final plans which they had approved. This matter has been dealt with in Part IV, Acquisition. The plans purchased contained the defect in design of the vertical axle assembly that was one of the direct causes of the accident.

Although invited by the Board to attend the public inquiry, Anton Schwarzkopf chose not to attend and give evidence.

The keeper plate at the lower end of the vertical trunnion is attached with four high-strength cap screws. As is described in detail in the Technical Issues section of this Report, it was intended that these fasteners be preloaded and that they be additionally fastened using a thread adhesive. Both the preloading and the use of thread adhesive are ways of ensuring that vibration loosening of the screws will not occur. The preloading provides an additional important service. A properly designed connection (especially, no gap within the connected material) containing preloaded screws will be protected against fatigue failure of the fasteners. As also described in Technical Issues, there is no written material before the Board with respect to the application of thread adhesive on the screws, but it is known that limited information was passed verbally from the manufacturer to B.K. Maintenance.

In each train there are a total of forty cap screws of the kind that connect the lower keeper plate to the vertical trunnion. On May 20, 1986, approximately one month before the accident, one of these screws was found to be broken (Ex. 168 from Red Train No. 4). Examination of this broken screw after the accident showed that it had failed by fatigue. Four cap screws vibrated completely loose in one vertical axle assembly in Yellow Train No. 1; this constituted the immediate cause of the accident on June 14, 1986. Subsequent to the accident, examination of these four particular keeper plate screws showed that one of them also evidenced fatigue cracking (Ex. 294, p.30). Examination of other keeper plate cap screws after the accident disclosed another screw fractured as a result of fatigue (Ex. 169) and a total of three screws with fatigue cracks that were not fractured completely through. Thus, six of the twenty-four screws examined for fatigue cracking showed evidence of such cracks (Ex. 217, Table 1) (Ex. 294).

The loosening of screws by vibration and the fatigue cracking of screws are both evidence that the vertical axle assembly was improperly designed. As noted in Part III, Technical Issues and in Part VI, Manufacturing, there were also manufacturing problems in this assembly.

The technical experts who testified (Montgomery, Hoogensen, and Breed) were in agreement that there were deficiencies in the design of the vertical axle assembly.

The Montgomery report stated as conclusions, among others:

> "(c) There was an error in the design and a flaw in the manufacture of the bogie connections. The error and flaw likely caused the vibratory loosening of the cap screws on the critical connection for Yellow Train #1 and the fatigue failure of other cap screws on Red Trains #3 and #4.
>
> (d) The error in the design was that gaps were left between the vertical

> trunnions and the bottom retainer plates of the bogie connections. The flaw in the manufacturing was that the clearances between the outside diameters of the vertical trunnions and the inside diameters of the bronze bearings were excessive. The gaps and excessive clearances combined to allow the vertical trunnions to move from side to side inside the bronze bearings relative to the bottom retainer plates during the operation of the ride. This relative movement subjected the cap screws between the trunnions and bottom plates to fluctuating transverse loads. Fluctuating transverse loads are known to cause the vibratory loosening and fatigue failure of cap screws." (Ex. 217, p. 64)

In testimony, Montgomery gave the opinion that the responsibility for the excessive clearances in the vertical trunnion - bronze bushing arrangement lay with the manufacturer (4838), and that the presence of the gap was the consequence of faulty design.

As described in Part III, Technical Issues, more accurate measurements than those used by Montgomery in arriving at the conclusions in his report were received later by the Board. These were the measurements taken by Beesley and Anderson (Ex. 301 and 306) and they have been described and evaluated in Part III. Following the introduction of the Beesley measurements, Montgomery agreed that these were more accurate and comprehensive than the ones that had been done under his direction (6146). However, with respect to the conclusions stated in his report (Ex. 217), he testified that the new, more accurate, measurements would not alter the basic conclusions contained in his report (6146).

Arthur Breed, who was the first technical expert to testify before the Board, made the following comments:

> "Q. Would the air gap, in your view, Mr. Breed, create a situation, or the air gap combined with the rest that you have talked about, create a situation where these bolts might fail?
>
> A. Yes.
>
> Q. How would that occur, in your opinion?
>
> A. Well, because of the total design, a small area of bronze in compression, which allows it to actually yield, actually flow and compress and stay compressed. The forces tending to turn the bronze, rotate as it goes around the corners. As evidenced by the burnishing, at the wrong place it's rotating some. That air gap, in my opinion, is a very difficult thing to handle.
>
> Q. The effect of all of those things, do you have an opinion as to what effect they might have on the four bolts that are attempting to hold this keeper plate to the vertical trunnion?
>
> A. In the case of extreme loadings on the particular bogie assembly being at the rear end, yes, it does have an effect. It has an effect even on the car in front of that.
>
> Q. What is that effect?
>
> A. Tending to loosen the screws. Once they start, it's only a question of time and operation of that particular train as to when they either fail and fatigue or come out. If all of them come out, you have catastrophe." (3944)

And later:

> "Q. As a layman, am I translating what you've told us today about the air gap as being if there was an air gap and if the keeper plate and the trunnion were fit together snug and the bolts or the screws were put to their proper torque, you, in effect, created one unit that

> acted in concert. But because there is the air gap, you are now putting pressure on the bolts themselves that is distinct and different from it being clamped together as a complete unit?
>
> A. By having the air gap, you have an anelastic member in that structure, where if you closed it tight, it's entirely elastic. The problem is to try to compress these bushings or the bearings, the steel bearings simultaneously with closing that face. And as I said, it would involve a machining job that you couldn't comprehend, I can't, on a commercial base. You're talking millionths of an inch.
>
> Q. Okay. But what I'm getting at, as a result of that air gap, is there more forces placed on each bolt than if there wasn't the air gap?
>
> A. There are more dynamic load. In other words, statically, if you put this thing together, tighten the screws down, the screws would sense no more load if it were solid than if it were air gapped.
>
> Now, what happens, though, is when you start to put all of these outside external loads on this structure, random vibration, heavy centrifugal force, alternation due..alternation in moments bending this arm inside on the left rear, you wouldn't, you immediately feel those in that screw because of that anelastic member, the air gap." (3973)

The Hoogensen report draws the conclusion that:

> "The cause of the roller coaster accident has been determined to be the result of an improper fabrication or design of a bolted connection used to retain the vertical trunnion inside the bearing of the wheel bogie." (Ex. 266, p. 2)

Werner Stengel, whose firm was part of the group designing, detailing, and manufacturing the trains, testified as follows:

"Q. Would a gap between the keeper plate and the vertical trunnion create any problem from your point of view or your experience?

A. I have to separate this a little bit. For the statical reason, I would prefer always to have contact, but for the mechanical reasons to press the bearings together, sometimes the designer for this part, they use a gap.

Q. Were you aware of that when...or was your office aware of that when page 243a was prepared?

A. We have been aware that the mechanical engineers do it sometimes, but not on this part.

Q. If I understand, for statical reasons you prefer contact between the plate and the trunnion?

A. That's correct.

Q. Is that so that they clamp together and forces of friction prevent them from twisting or turning?

A. That's not so easy to explain because it needs maybe two hours and more you have to study it, maybe two years. Let me tell you one reason. If you bring torque on a screw, you have a big pre-tension on the screw, and you have to look where are these pre-tension is going, and the best way is to be in contact, so you will be safe that the axle of the screw will always be vertical. Because if you bring from four screws by each screw 37 kilonewtons pre-tension on the plate, you will have small deflection. This is not visible by eye. It's very small, but it means the head of the screw is not completely vertical and 90^0 to the axle, and so you give some moments to the head of the screw, and that's not what it's supposed to be. And by the other hand, it's better to have contact, to have the friction direct from the keeper plate to the trunnion. So, that the main reasons we want to have contact." (4975)

The introduction of the gap between the end of the trunnion and the keeper plate had other effects. As has been described elsewhere, this had the likelihood of allowing more rotational or translational movement between the trunnion and the keeper plate, it had a strong influence on the preload in the fasteners, and it permitted local bending of the screws to occur and thereby influenced the fatigue cracking observed in many of the screws. The use of the gap as a means of precompressing the bearings (steel or bronze) was a design decision.

On the last day of the Public Hearings in the Fall of 1986, William Keur and Eskandar Ghermezian, on behalf of Triple Five, acknowledged the existence of design problems. Keur said that both European and Alberta consultants had been retained with respect to reopening the ride (5771). Ghermezian said with respect to design:

> "Q. And what, in fact, is going to happen with respect to design?
>
> A. The design, we have to have proper engineering design approved by authorities both in Europe and in Canada before we open it." (5778)

The direct cause of the accident that took place on June 14, 1986 was the loss of four cap screws in the vertical axle assembly of car number four, Yellow Train No. 1. The vibration loosening was, in part, the result of the design deficiencies in the assembly.

It is the view of the Board that one of Anton Schwarzkopf, the firm of IMA, or the firm of Werner Stengel Engineering Office, or some combination of the above was responsible for the design errors in the vertical trunnion assembly. These design errors include the presence of the gap, the thickness of the keeper plate, and the lack of instruction relating to thread adhesive.

VI. MANUFACTURING

The situation in which the roller coaster trains were manufactured is outlined in Part IV dealing with Acquisition. The Board heard evidence specifically from Viebahn, the plant manager, relating to the manufacturing process, although it was clear from the evidence that Viebahn did not have a "hands-on" responsibility with respect to the manufacturing process; that was the responsibility of Bachschmidt with respect to the track and Stein and Klein relating to the roller coaster trains.

Viebahn's evidence was that, prior to the bankruptcy in June of 1985, the work force of the plant had been about 160 employees and that after the bankruptcy, Schaffler, as Receiver, operated with a staff of approximately 100 employees. Viebahn's evidence was that there were no significant labour problems in relation to the operation of the plant during the completion of the roller coaster (4335-6). Bachschmidt, who was responsible for the fabrication of the track, and Stein, the plant production manager, remained in the employment of the Receiver after the bankruptcy (4303).

Viebahn testified that the machinery and the equipment in the plant was old (4292). If a lot of machining was required on a part, it would be contracted out because the machinery in the plant was not very good and it was inefficient (4310). With respect to the components of the vertical axle assembly, he did not know which items might have been manufactured internally and which might have been contracted out (4310-1). When the Schwarzkopf plant ordered materials, the supplier would supply a certificate as to the strength, chemical ingredients, and technical and physical conditions of the material. If a supplier was supplying a manufactured or machined part, the certificate only related to the material itself and not to the work (4308-9). The welders employed were licensed to do certain kinds of welding and worked under a supervisor who was qualified to supervise welding of that kind (4309-10). Viebahn could not testify as to the technical details of the quality control because he had been involved with the plant for only a short time (4310). Viebahn did not know whether any type testing documentation relating to the roller coaster had been supplied and he did not know whether the manufacturer had a recommended routine for non-destructive testing of critical ride components.

With respect to the track portion of the facility, Triple Five retained its own metallurgical engineer, Dr. Bruce Ball, to inspect the steel structure and to verify quality assurance. Dr. Ball testified that he was satisfied ultimately that the track portion had been properly manufactured and erected (502-4).

As described in Part III, Technical Issues, the Board concludes that the trunnions from the vertical axle assembly of the accident train which were measured were not within their prescribed tolerance when they were manufactured. The result was a clearance at the interface of the trunnions and their bronze bushings and this improper fit contributed directly to the loosening of the four cap screws and, thereby, to the accident.

In addition to the problem relating to tolerances, evidence was presented to the Board of Inquiry that an anaerobic thread adhesive was used on the cap screws in question. A prescribed use of such a thread adhesive is not referred to in any of the documentation relating to the roller coaster and it appears to the Board that a decision to use such a thread adhesive would have been made at the plant by the person in charge of the construction of the roller coaster trains. Keur testified that he was told by Bachschmidt and other representatives of Schwarzkopf GmbH that a thread adhesive had been used as the "second method" of securing the cap screws. As a result, the cap screws were not to be touched and any inspections of them would have to be visual

(3579) (3601) (1015-6) (1018-9). Stengel testified that Anton Schwarzkopf told him on June 15, 1986, that a thread adhesive was to be used on the cap screws and that heating would be required to break down the adhesive and permit removal of the cap screws (5037). Stengel also testified that Schwarzkopf was surprised when the cap screws were removed from the vertical axle assembly on the blue train in the B.K. Maintenance shop at Fantasyland on June 15, 1986 without the use of heat and with relatively little effort (5037-8). At the Hearings, Stengel produced a photocopy of the label of a bottle of thread adhesive (Ex. 240, p. 31). His evidence was that, after the accident, he made inquiries of Anton Schwarzkopf about this thread adhesive (5078-9). He reported that the reaction he got from Schwarzkopf was that he too was interested in what type of thread adhesive had been used because he was out of the company during the manufacturing process. Schwarzkopf indicated to Stengel that he had been advised by Klein that the material used was the same as indicated on the label provided by Stengel. Stengel's evidence was that it was his understanding from a representative of Loctite Corp. that the material described on the label photocopied was the same as their brand Loctite 242.

Dr. Montgomery, Dr. Hamre and the R.C.M.P. Crime Lab examined what was identified as the remnants of a thread adhesive compound on the cap screws and in the holes of the trunnion. Dr. Montgomery and Dr. Hamre each noticed in numerous cases that the distribution of the compound along the threads was uneven, and it was speculated that the thread adhesive may not have been applied in a proper fashion (Ex. 217, p. 33) (Ex. 263).

As described in Part III, Technical Issues, the Board concludes that the improper application of thread adhesive was a factor contributing to the loosening of the four cap screws and, thereby, to the accident.

After the accident, TUV inspected one of the trains of the roller coaster in Edmonton. One of the purposes was to check whether the actual construction was in accordance with the drawings or stress analysis. The inspector made an eighteen page Report dated August 27, 1986 (Ex. 213). The Report stated it was not possible for the grades of the materials to be checked (p. 2). In the wheel box (p. 4), the wheel bolt and the bearing bolts were of a strength grade 8.8 whereas a different material was assumed in the calculations. The bearing bolt mounting was already worn, with the DU bushing "heavily worn". The report suggested that wheel bolts and bearing bolts in this region must be secured against turning by a welded-on stop. In the wheel link for the track-wheel pair (p. 5), bearing seats for the track wheel have not in all cases been produced in accordance with the drawings: threaded holes have been drilled deeper than planned, notch radii are unequal and smaller than planned (less than 1 mm in some instances), the surface quality is less than desired, and so on. In the vertical axle assembly (p. 6), it is noted that the lower keeper plate is only 12 mm thick, whereas the drawing shows it to be 20 mm thick. (The Board notes that there are two drawings in evidence (Ex. 185 and Ex. 172) that show the thickness to be 12 mm.) The upper keeper plate is only 11.5 mm thick and the drawing shows a thickness of 20 mm. Screws of strength grade 12.9 are used instead of grade 10.9. The bearing bolt shows heavy wear and must be replaced. With respect to the coupling (p. 8 ff), the connecting bolts on the clamping ring were not tightened as specified and there were snap rings under the bolts rather than plain hardened washers. The main connecting bolts were strength grade 10.9; grade 8.8 had been specified. Bolt holes were irregular and had been re-worked with, in some cases, large hole clearances. It was suggested that lateral mounting bolts on the universal joint be pre-loaded. The bushings in this joint were also worn and replacement was suggested. There were deviations from the drawings as to the locations of certain supporting pieces and the coupling for the first axle does not conform to the calculations or the general drawing. The surface quality at the notch transition is not in conformance with requirements. The lid thickness in this coupling is smaller than prescribed (13 mm instead of 16 mm) and the bolts had not been joined by locking wire. The inspection Report observed that the coupling appears to have been constructed using cast steel. It also notes that clearance for the movement of the coupling is not sufficient. Finally, there were comments on the axle mounting on the chassis (p. 10). The front rubber can mounting has not been constructed as shown on the general drawing: a welded-on support has been replaced by a loose spacer bushing.

The TUV Report contains recommendations with respect to each of these items, as well as recommendations on a number of other items. In the summary, it concludes that the construction-related inspections showed that some details deviated from the requirements of the stress analysis and that signs of heavy wear were already evident (p. 18).

Leutenstorfer, a TUV engineer, was asked to comment on the TUV Report. He was not personally involved in either the inspection of the train in Edmonton or in the preparation of the Report. Leutenstorfer testified that in his opinion two of the deviations mentioned in the Report are significant: the use of snap rings with prestressed bolts and the use of cast iron in the couplings (5968). The remaining items are of 'a lower importance' in his view (5969) and may have been modifications by the manufacturer (6001). Leutenstorfer added that it used to be an acceptable practice to use snap rings, but he acknowledged that that practice is not proper today with prestressed bolts (5968). With respect to the use of cast iron, Leutenstorfer stated that because there are no standards in Germany for the welding of cast iron, it is not used. He suggested that "there might be some other countries which have some rules about this welding, how to handle with this welding, and so it might be possible to use it" (5968). The Board notes that, in contrast to Leutenstorfer's opinion on this point, Stengel was vehemently opposed to the use of cast iron in the roller coaster (5073).

In the Board's opinion, the use of snap rings with pre-stressed bolts and the use of cast iron in the couplings were not the only important deviations mentioned in the TUV Report. The Board notes that Leutenstorfer, in analyzing the roller coaster, generally appears to be concentrating on components essential to safety (5972).

The Board notes that Stengel testified about meeting with two engineers employed by TUV, one of whom had inspected the coaster in Edmonton after the accident and prepared the Report subsequently produced in the Hearings. That engineer expressed criticisms of the manufacturing (5181-2). Stengel also testified that the use of grade 12.9 screws is not allowed by the German standards under the building codes applicable to amusement rides because of the risk of hydrogen corrosion (5195). It came as a surprise to Stengel that these bolts were galvanized. He indicated there was no authorization on the drawings or in the static calculations to use galvanized bolts because the permissible load is reduced by fifteen percent (5027). Leutenstorfer likewise agreed that grade 12.9 screws were not permitted under the building codes or standards applicable to amusement rides (6027).

The Board is of the opinion that the majority of deficiencies noted in the TUV Report are defects which indicate a serious lack of quality control at the time of manufacture of the Triple Five coaster.

Keur also indicated that Triple Five had discovered parts to be missing in the steel structure holding the side and bottom bogie wheels on the bogie assembly (5769-70) (5772).

The owner must satisfy itself that the trains were properly manufactured. It is clear that the owner has recognized the problems in this regard, and on the last day of the Public Hearings held in the Fall of 1986, Keur gave evidence as follows:

> "Q. And what is the intention with respect to these deficiencies?
>
> A. That all of the cars is going to be sent back to a manufacturer in Germany, to have either those parts removed, or completely renewed, or the cars completely renewed.
>
> Q. What, in fact, is going to take place with the bogie assembly?
>
> A. It is going to be a complete different bogie systems installed.
>
> Q. What is going to happen with respect to the coupling system?
>
> A. The coupling is going to be completely redone and renewed and the steel goose -- the goose steel or casting is going to be removed.
>
> Q. And who is it that will be responsible for the supervision?
>
> A. Mr. Schwarzkopf, in total.
>
> Q. And will there be any governmental body that will be responsible for the supervision?
>
> A. The TUV will be the supervision and total inspection by TUV.
>
> Q. What has always been your instructions from Triple Five and Mr. Eskandar Ghermezian with respect to the area of safety?
>
> A. Safety first.
>
> Q. And what have been your instructions with respect to the resumption of the ride?
>
> A. Not to open it before we are completely satisfied that everything is to everybody's satisfaction is safe." (5770)

The Board has concluded that there were deficiencies in design and manufacture that were the direct cause of the accident that occurred on June 14, 1986. The manufacturing defect is that the trunnions of the bogie assembly were machined too small. The consequence of this was that the vertical axle was able to turn relative to the inside diameter of the bushings. Because a keeper plate which was bearing against the underside of the bushings was also screwed into the end of the vertical axle, a rotational or translational motion occurred between the trunnion and the keeper plate. As a consequence, there was a tendency for the screws to loosen. If there was any clearance at all between the inside diameter of the bushing and the outside diameter of the trunnion, the rotational motion could occur. If the clearances were excessive, the translational motion could also occur. The Board is not able to establish which motion predominated, but if at least the rotational movement took place, there would be a tendency for the screws to loosen.

The relative motion of the keeper plate and the trunnion, as described above, was contrary to the expectation of the designers. They intended that there be a tight fit between the trunnion and the bushings. Thereby, the trunnion, keeper plate, and bushings would all rotate as a unit as the car "steered" around the coaster track.

Because the dimensions of unused bushings were not available to the Board, the exact state of the bushings as machined cannot now be established. The condition of the bushings taken from the accident train was affected by wear and by deformation. Because the Board considers the evidence that the trunnions were manufactured undersize to be conclusive, the only way for wear or deformation in the bushings to have played a critical role in the creation of a clearance problem is for those bushings to have been deliberately manufactured to a diameter small enough to ensure a tight fit with the undersize trunnions. The likelihood of that having happened is extremely remote and there was no evidence before the Board from anyone to suggest that it did occur.

The Board has considered another possible explanation for the presence of clearance between the trunnions and bushings. The fit class selected for each of these components allows for a few cases of clearance; a transitional fit was selected. Thus, even for properly manufactured trunnions and bushings there will be a few cases where clearance will occur. The Board considers that the number of such cases is likely to be rather small. Any clearance problem created by the selection of the fit classes would be a design error, not a manufacturing error. In any event, the Board has concluded that the trunnions in the vertical axle assemblies of the accident train were machined too small. Thus, the clearances in those assemblies are not related to the selection of an improper fit class.

Based on the evidence before it, it is the view of the Board that the designers intended that fastener preload and the use of thread adhesive both be used to prevent vibration loosening of fasteners, even in a properly manufactured trunnion-bushing assembly. The Board has received evidence that the thread adhesive may not have been properly applied. If so, this deficiency is a manufacturing defect. The attainment of a proper preload in the fasteners using the prescribed torque value of 69 Newton-metres depends upon the presence of certain conditions. These are the use of fasteners with lightly lubricated threads and assembly in a connection in which all the parts are plane and in tight contact prior to application of the prescribed torque. The condition of the threads of the fasteners used did not meet the criteria above. Their threads were galvanized and they may have been lubricated by thread adhesive. Equally important, the presence of a gap between the end of the trunnion and the keeper plate and the introduction of an element more compressible than steel, the bronze bushings, means that the preload resulting from the application of a torque of 69 Newton-metres cannot be known with confidence.

In summary, the trains, as built, have a number of manufacturing defects, including:

(a) Trunnions machined too small;

(b) The uneven distribution of thread adhesive on the cap screws, indicating improper application;

(c) The items referred to in the TUV Report which generally indicated a lack of conformance with the drawings and items of unsatisfactory workmanship;

(d) The use of grade 12.9 galvanized fasteners;

(e) The missing parts in the steel structure holding the side and bottom bogie wheels.

In the opinion of the Board, all of these items are evidence of the lack of effective quality control referred to in Part IV of this Report dealing with Acquisition.

The Board concludes that the manufacturing defects in the trains of the roller coaster are the direct responsibility of Schwarzkopf GmbH or the Receiver of Schwarzkopf GmbH, Alfred Schaffler, or a combination thereof.

VII. CONSTRUCTION

In the category of Construction, the Board heard evidence from five witnesses representing four companies involved in the erection of the roller coaster at West Edmonton Mall. The first witness was Ross Grieve, representing PCL Construction Management Inc. ("PCL"). PCL had entered into a Construction Management Contract with West Edmonton Mall Ltd. for the expansion of Fantasyland. During the performance of that Contract, PCL became involved with some of the amusement rides slated for that area, including the roller coaster. In order to prepare a pre-tender package for the erection contract, plans of the roller coaster track were obtained by PCL and a representative of PCL went to the Schwarzkopf GmbH factory in Germany in March or April of 1985 to obtain further information. Once construction of the expansion commenced, PCL personnel provided a number of services on the site, including general supervision, coordination of trades and liaison. With respect to the roller coaster, PCL personnel unloaded materials for the track, and during the erection process, provided supervision, administration and coordination. As well, PCL obtained an English translation of the maintenance manual supplied in German by the manufacturer (Ex. 9) (418). Grieve indicated that there was no aspect of the project relating to the roller coaster that caused PCL concern (426).

The Board also heard evidence from Norman Parkin, a construction superintendent with PCL who was on the site at West Edmonton Mall and whose responsibilities included coordination and supervision of the trades involved in the expansion of Fantasyland, including the erection of the roller coaster. Parkin testified that he saw the delivery of the roller coaster materials and it was his recollection that the cars were the last to arrive (431). Schwarzkopf GmbH representatives supervised the unloading of the shipping containers and the sorting of the roller coaster materials. Parkin arranged to have the materials delivered to the site as required for the erection process. Representatives of Schwarzkopf GmbH supervised the actual erection. Parkin testified that he was on-site on a daily basis and was not aware of any problems arising during the process of erection of the roller coaster (439). He indicated that certain modifications to base plates were required because of misplaced anchor bolts in the concrete and that modifications were required to two columns because of clearance problems. Parkin observed the unloading of at least some of the roller coaster cars (443). It was his evidence that more than one car was packed in each container, but that the cars were not attached together. Each car arrived fully assembled. They were removed one by one from their containers and placed on the rail of the track. This process was supervised by representatives from Schwarzkopf GmbH. Finally, Parkin testified that PCL did no testing of the track or the trains (449).

Brian Brown, a project administrator with Northern Steel Inc., also gave evidence. He testified that Northern Steel Inc. contracted with West Edmonton Mall Ltd. for the supply and erection of steel for the building housing the expansion of Fantasyland and also for the erection only of three owner-supplied rides, including the roller coaster. The actual erection of the roller coaster was further sub-contracted by Northern Steel Inc. to Canron Inc. It was Brown's evidence that Northern Steel Inc. did not supervise Canron Inc. during the erection process and, generally, Northern Steel Inc. had no direct involvement in the erection process. Brown indicated that there were no problems of major consequence during the erection of the roller coaster, to his knowledge (459).

Dr. Bruce Ball, a metallurgical engineer and certified weld inspector and the principal of Ball Welding and Metallurgical Engineering Ltd., testified that his company contracted with West Edmonton Mall Ltd. to provide inspection services for the expansion of Fantasyland. Dr. Ball's responsibility with respect to the roller coaster was to provide a quality assurance function such that he could recommend to the owner that the erection of the roller coaster's structural components met good workmanship and engineering standards (470). He was not responsible for testing the trains (471). Dr. Ball testified that he inspected the roller coaster materials shortly after they were unloaded (477) and that non-destructive tests of the structural components were conducted on the site (471). Inspections continued during the erection process as required (477). Dr. Ball also testified that he ordered extra testing and re-torquing of bolts on the track structure when loose bolts were found after the December opening (476).

Dr. Ball testified that, in his opinion, the main structure was essentially complete on December 14, 1985 (485) and that it was structurally safe at that time (517). Therefore, he considered everything to be satisfactory and gave his opinion that the track could be put into use over Christmas (486). However, he was not prepared then to give his final approval (489). In his letter of March 5, 1986 (Ex. 66, p. 9), Dr. Ball expressed some concerns, based on his opinion that the design of the track and support structure was unconventional (490). He subsequently met with Stengel on March 12, 1986 (493). He testified that, after that meeting, he was satisfied that his questions had been answered and he was impressed with the design (494) (497) (518). As a result, he issued his final report dated May 12, 1986 (Ex. 66, p. 12). That report included recommendations regarding the owner's maintenance program for the roller coaster. Dr. Ball recommended at that time that the owner follow the maintenance manual for a period of at least one year, and then consider whether it would be necessary to continue that intensity of maintenance (502). Dr. Ball confirmed that when he recommended the ride for acceptance in his report of May 12, he was recommending the structural portion only because he had no responsibility with respect to inspecting the trains (503).

The last witness in this category was John Fletcher, a project administrator with Canron Inc. Canron Inc. had contracted with Northern Steel Inc. for the erection of the superstructure of the expansion of Fantasyland and for the erection of the structural portion of three amusement rides, including the roller coaster. Canron Inc. had no responsibility in connection with the cars (530). Fletcher testified that he was personally involved in the erection of the roller coaster supporting structure and was on-site on a daily basis. He described the sequence of erection of the roller coaster, some modifications which were required, testing that was performed on track and cap bolts in the support structure, and remedial action performed at the instruction of Dr. Ball. Fletcher testified that there were no problems in erecting the structure (573).

The Board is satisfied that the track and the surrounding structure were constructed in a competent fashion by qualified contractors. None of the contractors involved in this category, including PCL, Northern Steel Inc., and Canron Inc. had any responsibility with respect to the trains. Dr. Bruce Ball issued his final report in May of 1986 with respect to the track and gave evidence that he also had no responsibility with respect to the trains.

VIII. APPROVAL PROCESS

The Elevators and Fixed Conveyances Act, R.S.A. 1980, Chapter E-7 (Ex.21), sets out the role of the Elevators and Fixed Conveyances Branch ("EFC") of the Department of Labour in relation to the types of facilities covered by the Act. In Section 1(a) of the Act a fixed conveyance is defined as "a fixed system or device for conveyance to which this Act applies". By Alberta Regulation 275/74, amusement rides were designated as fixed conveyances to which the Act applies and by Alberta Regulation 276/74, Canadian Standards Association Standard Z267-1971, Midway Safety Code was adopted (Ex. 22). The focus of the Elevators and Fixed Conveyances Act is on elevators and other items for conveyance used in relation to a particular business such as a tramway or ski tow. The personnel from the Branch who gave evidence at the Hearings came from backgrounds primarily in the elevator area.

From a review of the legislation, an outline of the procedure to be followed relating to amusement ride operations under the Act is as follows:

(1) Prior to erecting or altering a ride, the owner is to submit all relevant plans, blueprints, drawings and specifications required by an inspector and construction is not to commence until such plans, blueprints, drawings and specifications have been certified as approved. If the plans, blueprints, drawings and specifications provide for the fulfillment of the requirements of the Act and the regulations, the Branch shall certify the plans, blueprints, drawings and specifications as approved. (Section 17)

(2) The chief inspector may approve or refuse to approve an amusement ride or any component of an amusement ride and no person can install an amusement ride of a type that the chief inspector has refused to approve. (Section 10)

(3) An inspector who notes a condition that contravenes a regulation or is inconsistent with good operating practices can require the owner to take remedial action and

when an inspector notes an unsafe condition, he may direct that the amusement ride be taken out of service. (Section 11)

(4) The Lieutenant Governor in Council is given the authority to make regulations with respect to a number of items, including the construction, maintenance and use of any type or class of fixed conveyance. (Section 21)

The general procedure followed by the Elevators and Fixed Conveyances Branch with respect to its work relating to fixed conveyances and specifically amusement rides was described in the evidence of Stephen Millward, the Chief Inspector of the Branch. While the regulations refer to CSA Standard Z267-1971 Midway Safety Code (Ex. 23) for amusement rides, Millward indicated that, unofficially, EFC uses CSA Standard Z267M-1983 Midway Safety Code (Ex. 24) (282). EFC inspects both temporary or travelling amusement ride facilities and permanent facilities. There are presently three permanent facilities in Alberta: Fantasyland, Calaway Park and a small park in Bowness. Fantasyland is the largest such facility and has more sophisticated rides.

Millward provided the Board with an outline or summary of the procedures adopted by EFC with respect to inspections of all types of fixed conveyances (Ex. 25). His Branch requires that plans and specifications pertaining to each given project be submitted for examination and the Branch record. Those documents are to be endorsed by a professional engineer. Millward indicated that the purpose of this requirement is to have a record of the project and to be able to confirm that there are, in fact, plans and specifications in existence (286). As well, the reason for the endorsement is to verify that an engineer has checked that the design and specifications are in accordance with the standard and accepted practices for the industry (286). On receipt, EFC reviews the documents, not in minute detail, and points out any obvious problems (287). Millward stated that EFC does not "approve" the documents, but rather stamps them as "examined" (288). EFC also requires a copy of the Maintenance and Operating Manuals for the facility in order to ensure that such Manuals exist (287).

Millward described the ongoing inspection process for complex projects (289). First, there will be a "pre-inspection" during the construction or erection phase. Then, EFC conducts an "initial inspection" upon completion of the installation, but prior to operation. This initial inspection is called a "monitoring check" and consists of a visual examination of the equipment, load and speed tests, and tests of safety features.

It should be noted that the Act does not require the approval of an amusement ride for operation and Millward indicated that it may be somewhat misleading to use the term "approve" in connection with the procedure followed by EFC (291). Following the initial inspection, EFC compiles a report listing any deficiencies or directives to be addressed before the unit goes into operation. This is then sent to the supervisory people on site and to the owner or operator on the understanding that once all of the directives have been addressed, the ride may go into operation (292). Millward testified that no letter or Certificate of final approval is issued by his Branch, although there may be instances in which EFC directs that a facility not be operated (292).

Allan Griffin, an inspector with EFC, described the annual inspection of rides in permanent facilities conducted by his Branch (1292). He stated that such annual inspections are a total or general inspection. By and large, the same sort of inspection is conducted at the annual inspection as if EFC was inspecting the ride all over again (1294-6). Included in the annual inspection is a check of the log books, maintenance schedule and flow sheets to see if in fact the owners have a maintenance program in place for the ride (1296).

Griffin is the inspector responsible for the territory which includes Fantasyland. Rodney Karen is the senior inspector in the Edmonton office of EFC. Griffin and Karen provided a review of the history of EFC's file with respect to the roller coaster, as follows:

> Letter of January 3, 1985 (Ex. 38): This letter sets out the general and specific information requested by EFC from Triple Five with respect to the proposed rides for Phase II of Fantasyland (306-8). Prior to this letter, in December of 1984, an information meeting was held to discuss the expansion of Fantasyland (1400-2). Millward, Karen, Griffin, Mooney, Keur and McCarthy attended that meeting. One of the rides mentioned was the triple loop roller coaster (303-6). Exhibit 38 was intended as a follow-up to that meeting.
>
> Letter of April 12, 1985 (Ex. 114): Griffin's evidence was that this letter was received in April of 1985 and he and Karen confirmed that German welding standards exceeded Canadian standards (1410).
>
> Letter of April 12, 1985 (Ex. 115): Griffin indicated that this letter was misfiled upon receipt and, to his knowledge, never reviewed by EFC (1411). Griffin also testified that, other than Exhibit 114, EFC did not receive details of non-destructive or destructive tests conducted during the manufacturing process on critical components of the roller coaster, as requested in Exhibit 38 (359) (1417).
>
> Letter of August 29, 1985 (Ex. 40): By the date of this letter, construction of the roller coaster had commenced and EFC had not received plans, blueprints, drawings or specifications.
>
> Letter of December 9, 1985 (Ex. 45): Prior to the date of this letter, EFC had received a set of electrical drawings for the roller coaster (Ex. 44) and a set of plans for the track only. The latter were not endorsed by an engineer (310-3) (315-9). In Exhibit 45, EFC requested "engineer endorsed structural verification including construction of the cars..."
>
> Letter of December 20, 1985 (Ex. 43): Prior to the date of this letter, EFC had looked at approximately 6,800 pages of calculations at the roller coaster site and had discovered that they were not endorsed with an engineer's stamp. As a result, they asked PCL to obtain an endorsed version (322).

Letter of December 20, 1985 (Ex. 10): The initial inspection of the roller coaster was conducted on December 20, 1985 and the ride was opened to the public on a temporary basis on that day (see below). Exhibit 10 was received prior to the commencement of the inspection on December 20 (362).

Letter of December 24, 1985 (Ex. 55)

Letter of January 2, 1986 (Ex. 47): This letter attaches a copy of Griffin's inspection report of December 20, 1985. The directives identified in that report as requiring immediate attention were done on December 20, 1985, prior to the opening of the ride (335).

Letter of January 14, 1986 (Ex. 48): Prior to the operation of the ride at Christmas, EFC had received a Maintenance and Operation Manual in German (Ex. 8) (337). They requested that an English translation be provided. As well, as of that date they had not received a set of calculations endorsed by an engineer and therefore requested the same.

Memo of January 27, 1986 (Ex. 49)

Letter of February 14, 1986 (Ex. 52): By this date, EFC had received a translation of the Manual into English (Ex. 9). Karen testified that he does not recall ever receiving a translation of the electrical drawings (1442). He indicated that he received two copies of the translated Manual, one from Keur and one from PCL (1442).

Letter of February 21, 1986 (Ex. 53): This letter acknowledges receipt of endorsed plans (Exs. 25 to 36 and 39), an endorsed verification (Ex. 54) and the Manual in English (Ex. 9). Karen testified that he received these documents from Keur (1445) (Keur, 610-24). Karen indicated that the purpose of this letter was to advise that he was not going to ask for any more documents (1445).

Karen testified that he examined the plans obtained by EFC for the roller coaster, but did not do any design analysis on them (1432). After his review, the plans were stamped as "examined", which Karen stated meant "certified as approved", as set out in Section 17(2) of the Elevators and Fixed Conveyances Act (1459). Karen also indicated that the purpose of obtaining translations of the electrical information and the Maintenance Manual was to have them available for future reference by EFC in its ongoing inspection procedure and therefore he did not review them in detail upon receipt (1443).

It is important to note that in December, 1985, EFC did not receive any plans or drawings for the trains. These were not received until Stengel forwarded his documents, including Exhibit 36, in February of 1986. Karen stated that he did not know whether Werner Stengel was a registered professional engineer (1396-7). Griffin indicated that he believed Stengel was registered professionally in Germany, but he had no specific information in that regard (355).

Wolfgang Viebahn, who had been the plant manager for Schwarzkopf GmbH during the manufacturing of the roller coaster, was shown Exhibit 199, which included a number of documents produced in the proceedings by PCL Construction Management Ltd. ("PCL"). Viebahn was specifically shown a series of Telexes from PCL to himself in November of 1985 asking for his assistance in obtaining the documents required by EFC (Ex. 199, p. 34-6). Viebahn's evidence was that he tried to assist, but was not very successful (4358). In June of 1985, he gave Mooney some plans and in excess of 6,000 pages of calculations (4359). In December of 1985, Viebahn talked to Stengel about obtaining plans signed by an engineer (4359). This conversation was recorded in Viebahn's Telex of December 13, 1985 to Mooney (Ex. 199, p. 45). It was Viebahn's evidence that he was not involved in obtaining Exhibit 54 (4359). Also in December of 1985, Viebahn received a Telex from PCL regarding further information required by EFC (Ex. 199, p. 49). Viebahn indicated that he sent some material over with Bachschmidt before Christmas, but this material did not include everything requested by EFC (4360).

Werner Stengel, whose firm prepared the static calculations for the roller coaster, testified that he was asked by Triple Five in January or February of 1986 to prepare and send a complete copy of all drawings and the calculations for EFC (5001). To that date, he had not prepared "Construction Book" - type drawings for the triple loop roller coaster and at that time had no intention of doing so because he had not been paid in full for his firm's work (5002). He was ultimately paid approximately 8,000 German Marks (5001) for providing the documents requested by Triple Five. Stengel testified that his firm took the drawings they had prepared for the Construction Book submitted to TUV with respect to the four loop roller coaster (eg. Ex. 234 and 235), made a copy, changed the job number and name to correspond to the three loop roller coaster and then sent those documents to Triple Five (5002). To Stengel's knowledge, the trains for both rides were exactly the same (5002). Stengel indicated that these Construction Book drawings are simplified sketches, with no tolerances or details (4995) (5195). There appears to be some confusion with respect to the dates. Stengel's evidence was that the material was sent to Triple Five with a covering letter dated February 24, 1986 (Ex. 286, item 7) (5018). This date conflicts with Exhibit 53, dated February 21, 1986. Stengel also indicated that he wrote Exhibit 54 at the request of Triple Five at the same time that he sent the endorsed plans to Edmonton (5017). The date of Exhibit 54 is January 22, 1986.

Karen and Griffin testified as to the various inspections conducted by them on the roller coaster. Because this was an ongoing situation (331), pre-inspections were conducted during the construction process (327) (1446) from time to time for a total of approximately 50 to 60 hours (328). There are no written reports of those pre-inspections (331). Exhibit 40 is an example of a concern expressed on one occasion by EFC.

On December 20, 1985, Karen and Griffin conducted an "initial inspection" of the roller coaster (333). Included in this inspection was a visual inspection of the two red and two yellow trains. The trains were loaded to capacity using sandbags and run through the track and "E" brake system. A written report was prepared (Ex. 47 - attachment) and the deficiencies marked "immediately" were repaired that evening (335). EFC then let Triple Five operate the ride (335).

From the time the ride closed in January of 1986 through to March of that year, EFC conducted ongoing inspections which in effect amounted to a multi-staged inspection (1439). On March 16, 1986, the date of the second opening of the roller coaster, EFC conducted the final step in the process. Griffin and Karen checked the two blue trains (1439) in an inspection similar to the one conducted on December 20 with respect to the other four trains (1452). They did not repeat the entire inspection of December 20 (1439).

Ken Glenn, the operations manager for Fantasyland, testified that he was involved in operating the roller coaster over Christmas of 1985. Glenn's evidence was that all six trains ran for some time during that period (3434) (3452). The two blue trains were substituted for the two yellow trains midway through, while the two red trains ran for the entire period. This was reflected in the report on ride timings (Ex. 88, p. 18).

As noted above, Millward indicated to the Board that it may be somewhat misleading to use the term "approval" in connection with the procedure followed by EFC. Griffin's evidence was that he did not instruct Triple Five to open the roller coaster on December 20, 1985 (381). Karen testified that no documentation was issued after the inspection in March of 1986 such as to approve the operation of the ride on a permanent basis (1460). He believed that Triple Five was told verbally it could proceed (1460). Karen further stated that, technically, the final approval contemplated by Exhibit 48 was never given (1433). In Karen's opinion, Exhibit 47 should have been identified as an "inspection for temporary operation" and there should have been another document identified as the "initial inspection" issued in March of 1986 (1434).

Griffin testified that maintenance documents for a facility would be reviewed by EFC during the annual inspection of that facility (1296). Karen stated that he had requested the translation of the Maintenance Manual for the roller coaster in order to have it available for future reference by EFC in its ongoing inspection procedure (1443). He indicated that generally EFC plays practically no role in connection with the maintenance of the facilities it inspects (1460). However, during the course of ongoing inspections of existing facilities, EFC may identify deficiencies which are indicative of a maintenance problem (1461) (1513). In that case, directives would be issued to bring these things to the owner's attention (1461) (1513).

Exhibit 103 is an example of particular instances wherein EFC became involved with Triple Five's maintenance program at Fantasyland (1300) (1461). In March of 1985, Griffin had done inspections of Phase I of Fantasyland and noted some areas of concern in the maintenance program (1301-1304) (1461). At that time, according to Griffin, David Penn, the senior supervisor of the Fantasyland maintenance staff, was relatively new to the amusement ride industry (1308). He asked Griffin for ideas to fill the gaps in the maintenance area (1301). Griffin suggested maintenance schedule sheets (1306). Penn promised improvement but Griffin wanted to be sure (1308). Meanwhile, Karen had talked to "Leo", who was then in charge of the maintenance staff at Fantasyland and who said that the maintenance department did not have enough time to do their work (1462).

As a result, Griffin and Karen wrote the letter dated March 27, 1985 (Ex. 103). According to Griffin, this was "as strong a piece of literature that we could possibly put out from the Branch" (1308). Karen and Griffin stated that Exhibit 103 was intended to apply both to future rides and to the roller coaster (1301) (1464). In response to Exhibit 103, Keur and Penn asked for a meeting on April 23, 1985 with Millward and Griffin (1309). The day before, at Millward's request, Griffin set out his thoughts on paper (Ex. 113) (1303). At the meeting, Keur and Penn indicated that they had already instituted documents similar to Exhibits 105 and 108 in Phase I and would be bringing on new non-destructive testing (1310). EFC did receive non-destructive testing reports, but did not do another complete inspection until June 18, 1986 (1312). At that time, Griffin found documents similar to Exhibits 105 and 108 in place with respect to the various rides in Phase I (1310).

Griffin stated that he did not know what maintenance program was in place with respect to the three loop roller coaster before the date of the accident (1314). He also stated that, as of June, 1986, he was satisfied that the maintenance at Fantasyland was being conducted in a "first class" fashion (1327) (3285). Later in his evidence, Griffin clarified that answer, indicating that, in his opinion, the maintenance procedures he understood were being adopted in Fantasyland subsequent to Exhibit 103 were excellent. He assumed the same procedures were in place or in the process of being adopted for the roller coaster (3310).

Karen indicated that between March of 1986 and June 14, 1986, he had no knowledge of what maintenance procedure was being followed by B.K. Maintenance with respect to the triple loop roller coaster (1469). After the accident, he briefly reviewed the maintenance documents (1469) (3030), but he was not aware of whether any flow charts were being kept to record maintenance work on the roller coaster (1468). Karen testified that he was told by Keur in December, 1985, that representatives of Schwarzkopf GmbH would provide training to B.K. Maintenance staff at Christmas (1469). He stated that, from his overview of the maintenance documents, he thought there may have been some lack of organization in the maintenance of the roller coaster (1495) (3032). Later, Karen stated that, in coming to that conclusion, he had focused on the log book (Ex. 91) for a couple of hours and had not had an opportunity to observe the actual maintenance program (3225-33). Karen stated that after the accident, EFC asked for checklists relating to the Phase II rides and was advised that at that time there were no checklists in the form eventually prepared (3033). Karen added that his office requested checklists be prepared for the rides in Phase II prior to re-opening of those rides and this was done (3034).

Griffin testified that he first learned approximately two weeks after the accident that a red cap screw was found about May 21 (1325) (3322). Karen stated he was advised shortly after the accident that the cap screw had come out (1517).

Karen indicated that EFC had received telephone complaints of neck injuries suffered by people riding the roller coaster (1475). He telephoned Keur in April of 1986 to discuss these complaints (Ex. 117) (1475). A summary of these complaints was subsequently forwarded to Keur (Ex. 280) (1476). Karen and Griffin met with Keur on May 1 (Ex. 118) just before Keur went to Germany to talk with Stengel about this problem and the problem of unusual wear on the roller coaster tires (1476). Keur later reported to Millward that the neck injuries were considered by Stengel to be the result of improper posture and tension on the part of the passenger (1478) (3514).

Karen gave evidence that on August 28, 1986, a meeting was held at Calaway Park in Calgary, Alberta, and that all of the inspectors of elevators and fixed conveyances for the Province of Alberta were present (3040-8). The meeting was also attended by Richard Coulter, a consultant from Ohio who discussed safety, problem rides and inspections in relation to the amusement ride industry. Karen indicated that this was the first meeting of this type that had ever been held by EFC relating to amusement park rides (3040). Exhibits 290 and 291 relate to the meeting held on August 28.

As indicated in the evidence, it is clear that, with respect to Triple Five's roller coaster, construction of the roller coaster had commenced and was almost completed prior to any plans, blueprints, drawings or specifications having been stamped by the Elevators and Fixed Conveyances Branch. Karen's letter of August 29, 1985 (Ex. 40) states that Griffin had been advised that the erection of the roller coaster had begun and requested submission of items asked for in the January 3, 1985 correspondence (Ex. 38). As indicated above, Karen gave evidence that Exhibit 47 should have been identified as an "inspection for temporary operation" and there should have been another document identified as "initial inspection" issued in March of 1986.

The Board concludes that the role of Elevators and Fixed Conveyances Branch is not clearly defined by the legislation or regulations with respect to amusement park operations. The practice developed by Elevators and Fixed Conveyances Branch was to obtain plans and specifications for the purpose of determining that an engineer had checked the design, to obtain Maintenance and Operation Manuals for the facility in order to ensure that such Manuals existed, and to perform inspections for the purpose of making any observations that they might feel were appropriate with respect to the facility, including the maintenance of the facility. In the circumstances, the Board concludes that the representatives of Elevators and Fixed Conveyances Branch took reasonable steps to deal with the Fantasyland project in accordance with what they perceived to be their duties and responsiblities under the applicable legislation and regulations, and that their efforts did result in certain documentation being received.

IX. COMMISSIONING

The process called "Commissioning" refers to work done during the period of about two weeks prior to the opening of the roller coaster at Christmas, 1985 when representatives of Schwarzkopf GmbH came to Edmonton from Germany. A total of four Germans were involved in the commissioning process: Bachschmidt, Rogg, Schuler, and Altmier (4337). As well, a Mr. Nobel, who was apparently also a representative of Schwarzkopf GmbH, assisted in the commissioning. They arrived prior to the unloading of the roller coaster cars and supervised the unloading and placing of the cars on the track and the coupling together of the cars. At least some of the Germans then stayed over the Christmas period to supervise the operation of the ride and to train Triple Five maintenance and operations personnel (2057).

Keur described the testing done by the Schwarzkopf GmbH representatives as part of the commissioning process, although he acknowledged that he had not observed all of the testing personally. Keur's understanding was that all six trains were on the track during the commissioning (653) and for the Christmas period (5767). No written report of the tests was obtained, but Triple Five did receive a confirmation letter that the ride had been tested (Ex. 10) (654).

Keur testified that on July 5, 1986, he had a discussion in Germany with Bachschmidt and asked Bachschmidt about the tests conducted on the trains during the commissioning process (5768). Keur stated that Bachschmidt assured him that he (Bachschmidt) had performed the fifty hour inspection of the trains required by the Maintenance Manual (5768). Bachschmidt further indicated that he had performed a visual check of the four cap screws on the bottom of the keeper plate of the vertical axle at that time (5773).

Certain maintenance personnel from B.K. Maintenance were present during the commissioning process in order to become familiar with the ride and to ask questions of the Schwarzkopf GmbH representatives (655). Lester Maleszewski, Alan Mrochuk, John Kowalkowski, David Pipke and John van den Brande all gave evidence with respect to the training they received on the roller coaster during this period. Maleszewski stated that one of the German mechanics told him if the Manual does not say to torque a cap screw, that means there is Loctite on that cap screw and it is not to be touched. Maleszewski understood that this included the four cap screws on the bottom of the vertical axle assembly (2112) (2166). He also stated that he and van den Brande did the fifty hour check with Schuler and they did a visual inspection of the four cap screws on the bottom of the vertical axle assembly at that time (2174). As well, Keur indicated that he had discussions with the Schwarzkopf GmbH representatives over the Christmas period. He was told that the four cap screws on the bottom of the vertical axle assembly were torqued and put in with an adhesive - Loctite - and the B.K. Maintenance personnel were not to touch them (3579) (3601) (1015) (1018).

Ken Glenn testified that he was trained by the Schwarzkopf GmbH representatives in the operation of the ride (3425). The Schwarzkopf GmbH representatives did not provide operation documentation at that time and the instruction received by Glenn was verbal only. The Germans then assisted Glenn in training the Fantasyland assistant managers and the park supervisors and also assisted in the preparation of the initial draft Operations Manual used during the Christmas period (Ex. 88) (3427). Evidence with respect to training of operations personnel by the Schwarzkopf GmbH representatives was also given by Doug Hansen, who worked as an attendant on the roller coaster during the Christmas period (3478).

It is difficult for the Board to comment upon the testing and commissioning process because there were no records of that process available. In the opinion of the Board, it would have been desirable if records and documentation had been created during the commissioning period by the owners. Because no records were kept, the value of any instructions received by Triple Five or B.K. Maintenance personnel from the German staff would have been minimal. Without written records, there is a risk that different individuals might interpret the same instructions in different ways, particularly when a language barrier existed at least to some extent. Likewise, lack of written records meant that the verbal transmission of information was subject to the consequences of the passage of time as information was forgotten or as those who were trained during this period left the employ of Triple Five or B.K. Maintenance. It is the Board's view that much of the usefulness of any training that was received during the commissioning period was lost.

X. OPERATIONS

The Operations Department of Fantasyland is separate and apart from the Maintenance Department and is headed up by Bill Canner, General Manager of Fantasyland. Canner's responsibilities include promoting, coordinating, directing and operating the various amusement and recreation facilities within the West Edmonton Mall complex. Other than the light maintenance staff, Canner's department does not have any maintenance responsibilities. Canner reports directly to the Ghermezian family.

The Operations Manager, Ken Glenn, reports to Canner and is largely responsible for the day-to-day operation management of Fantasyland. Under Glenn there are the park supervisors, area supervisors, and the ride operators and attendants.

The documentation produced to the Board with respect to the Operations Department of Fantasyland included an initial draft of an operations manual prepared for the period December 20, 1985 to January 5, 1986, which included on page 4 a list of "must haves" (Ex. 88). Attendant and Operator Manuals were subsequently prepared and apparently completed in May of 1986 (Ex. 86 and 87). The evidence of Shaun Cariou was that he was the training coordinator and area supervisor from March of 1986 to June 14 and that he prepared Exhibits 86 and 87. He indicated that Exhibits 86 and 87 were not distributed to the attendants or operators, but were used by the training team to train attendants and operators. Cariou indicated that a certification program was developed late in May of 1986 and that a record was kept for each particular operator or attendant, including their certification for each ride. Similarly, Cariou indicated that Exhibit 128, an example of an inter-office memorandum, was reviewed with each operator.

The evidence of the representatives of the Operations Department was that the training process was largely that of on-the-job training with experienced operators or attendants. David Smith's evidence with respect to his training on the roller coaster was that he was trained for a period of three days by an experienced operator in order to familiarize himself with the roller coaster and with the sounds and activities surrounding the ride. After the initial three day training program, Smith's evidence was that he was then allowed to operate the ride with an experienced operator present and eventually operated it on his own. Smith indicated that for the period commencing the middle of May to June 14, 1986, he worked as an operator on three rides, the roller coaster, the Fireball and the Free Fall and that his time was fairly evenly split among the three rides (2803). Similar evidence from others, including attendants, relating to the training program was presented to the Board.

The Board heard evidence from operators and attendants as to their duties and responsibilities with respect to the operations of the roller coaster and on the instrumentation involving the roller coaster. Smith gave evidence as to the general procedure that he followed with respect to a train completing a circuit around the track (2805). It was clear from the evidence and confirmed by Smith that the operator had no control over the roller coaster between braking stations (2828). Dean Jordan gave evidence as to the duties and responsibilities of the attendants. He described the communication between the operator and the attendants, and the procedure followed by the attendants, including the checking of lap bars.

The evidence disclosed that there were three daily shifts of operations personnel, including a "break shift" that relieved various operators and attendants with respect to lunch and dinner breaks.

At the time of the accident and for the hours immediately preceding the accident, David Smith was the operator of the roller coaster. Dean Jordan and Cameron Kapty were the loading attendants and Garry Cunningham was the unloading attendant.

As described in detail in the section of this Report dealing with the Accident, Smith testified that at approximately 8:10 p.m. on June 14, he heard a clanking noise coming from Yellow Train No. 1 as it went underneath the Fireball ride. Smith was certain that the noise came from Train No. 1 and he heard it twice from the same train. He described the sound as "metal on metal". He shut the ride down and called for a maintenance person to assist him. Al Zylstra from the Maintenance Department attended at the ride. A detailed description of Zylstra's involvement is contained in the Maintenance section of this Report. Zylstra instructed Smith to continue operating the ride. Approximately an hour to an hour and a half later Smith stopped Yellow Train No. 2 in the up-drive because he noticed that a generator belt was hanging down from the front car.

Dean Jordan gave evidence that he also heard a strange noise which he described as a clanking noise, coming from a yellow train. Jordan was not certain which yellow train was involved, although he confirmed that he had heard the sound from the same train on two different occasions. Kapty's evidence was that he heard noises, which he described as a scraping of metal, twice and that they came from Yellow Train No. 1. He and Jordan told Smith about the noises. Garry Cunningham, who was working further away from the operator's booth and the loading attendants, testified that he did not hear any unusual noises.

The Board is satisfied that in fact Smith, Jordan and Kapty did hear unusual noises and that such noises related to Yellow Train No. 1. The Board was impressed by the evidence of the people in the operations area and specifically with the evidence of Smith, Jordan and Kapty relating to the noises that were heard. The Board's view is that the operations personnel acted responsibly in contacting the Maintenance Department and alerting the Maintenance Department of their concerns relating to the noises. It is clear that, at that time, responsibility for the ride shifted from the Operations Department to the Maintenance Department. Glenn's evidence was that the operators or attendants are fully authorized to shut down rides at any time if they feel there is something of concern, and their responsibility is then to contact an office that in turn contacts the Maintenance Department (3440). Glenn's evidence with respect to re-starting the ride was as follows:

> "Q. And are they given instructions as to the re-starting of the ride Mr. Glenn?
>
> A. Yes, for the most part, the ride would be re-started by the Maintenance Department. Once all the guests have been removed, the ride would be thoroughly checked out by electrical and/or mechanical and then re-started and run for numerous times, depending on what the situation was, by the Maintenance Department, and then turned back over to Operations for opening to the public." (3441)

The Board concludes that the roller coaster was operated through an Operations Department that was well run and did an efficient and competent job on operations. Although certain of the documentation, including the Operator and Attendant Manuals, should have been in place prior to the commencement of the operation of the roller coaster on March 15, 1986, the Board concludes that the activities of the Operations Department had nothing to do with the accident and that the representatives of the Operations Department conducted themselves in a proper fashion with respect to the operation of the roller coaster.

XI. MAINTENANCE

The Board heard a great deal of evidence in the maintenance category, including evidence from personnel employed by B.K. Maintenance Ltd. and expert evidence. In dealing with this particular category, the Report will be broken into two main sections, the first dealing with general maintenance and the second dealing with specific items relating to maintenance. Under the second section there will be a further breakdown as indicated in the Report.

A. GENERAL MAINTENANCE

The Board heard expert evidence in the area of maintenance programs from Larry McLachlan, P. Eng., a mechanical engineer who is Director of Light Rail Equipment for Edmonton Transit. Exhibit 153 is a summary by McLachlan of general maintenance principles and his view of the documentation required for an effective maintenance program. McLachlan explained the steps involved in setting up a formal program of maintenance (3848-9). First, it is necessary for the owner or operator to gather whatever information is available relating to the particular equipment in question (3854). Actual maintenance procedures for different components must be developed (3855). A system of record keeping and other documentation must be established in order to develop a history for the equipment (3868). In McLachlan's view, an important ingredient in any maintenance program is the development of a training program for those who will be doing the work. A basis for the intervals of regular inspections must be established and, from that, schedules developed for preventative maintenance and regular repairs (3855). As well, there must be some procedure in place to monitor the effectiveness of the preventative maintenance program. In the Board's opinion, programs for preventative maintenance and scheduled repairs, plus the supporting documentation for those programs, must be in place before a facility begins full operation (3848) (3865). Those programs and documents will then develop further over time as the owner or operator gains experience with the equipment.

The experience of Triple Five and its maintenance subsidiary, B.K. Maintenance Ltd., in maintaining the triple loop roller coaster may be divided into four time periods. The first period started with the decision to purchase the triple loop roller coaster and concluded when the ride was ready to be operated. The second period runs from approximately December 21, 1985 to January 5, 1986, during which time the roller coaster was in temporary operation for the public under the supervision of representatives of the manufacturer. From January 5 to March 14, 1986, the roller coaster was not operational, as construction work continued to complete the Fantasyland expansion. Finally, from March 15 to June 14, 1986, the ride was in full operation every day for the public.

During the first period, B.K. Maintenance staff should have been considering what procedures, staff and equipment would be necessary to maintain the coaster, identifying and collecting the documentation necessary to maintain the coaster, and asking for advice from those knowledgeable in the field. B.K. Maintenance had no experience with an amusement ride of the level of the one that was being acquired.

From approximately December 21, 1985 to January 5, 1986, some representatives of Schwarzkopf GmbH stayed in Edmonton to supervise the operation of the roller coaster over the Christmas holiday (652-6) (2057) (2064). Their primary purpose apparently was trouble shooting of the new ride. During this period, some of the senior Triple Five operations personnel were taught to run the ride (3425-8) (3478-9). As well, three electrical and two mechanical maintenance personnel observed the manufacturer's representatives in order to become familiar with the ride and to ask questions (655). Based on the evidence, the Board's view is that there was no organized training program in the maintenance area at this time (2056-64) (2112) (2165-70) (2173-4) (2185-94) (2276-8) (2447-58) (2567-72). Pipke, an electrician, took some notes of his discussions with the manufacturer's representatives and kept them for reference (Exs. 121 and 122). One mechanic, Maleszewski, testified that he also took notes during this period but they were subsequently lost (Ex. 281). At this time, maintenance personnel had access to the German language version of the Maintenance Manual (Ex. 8), plans of the track only, which were not signed by an engineer (310-3) (315-9), and electrical drawings (Ex. 44) (Exs. 45 and 48).

The roller coaster was closed to the public from January 5 to March 14, 1986 in order to allow for the completion of the building housing the ride. No maintenance work was done on the roller coaster until shortly before the grand opening, at which time all of the trains were cleaned and checked (2064-5) (2169). During this period, an English translation of the Maintenance Manual (Ex. 9) and engineer endorsed plans for both the track and the trains were obtained (Exs. 25 through 36, 39 and 53). However, no steps were taken by Triple Five or B.K. Maintenance to set up a maintenance program for the roller coaster. Werner Stengel came to Edmonton in the middle of March and met with maintenance personnel (2233-6). He reviewed the Maintenance Manual (Ex. 90) with them (2234-5) (2479-81).

The grand opening of the triple loop roller coaster and the Fantasyland expansion took place on March 15, 1986. From that date until the date of the accident, the roller coaster was in full operation for the public. During that period, the senior management of Triple Five and B.K. Maintenance concerned with the maintenance of Fantasyland rides and attractions consisted of three individuals: William Keur, David Penn and Isaac Brower-Berkhoven.

Keur is the Mechanical Director of Triple Five and President of B.K. Maintenance (209-10). He is responsible for the maintenance of all of Triple Five's properties in Edmonton. His own background is as a master electrician. Keur stated that he was not involved in and was unfamiliar with the day-to-day maintenance program of Fantasyland (962-3) and he deferred at numerous points in his testimony to Penn.

Penn, Keur's second in command, is the senior supervisor of the Fantasyland maintenance staff (1023-6). He started in Fantasyland in the Spring of 1984 and transferred to another division of Triple Five in the Fall of 1985. He then returned to Fantasyland in March of 1986 (1027) (1035) (2054-5). Penn is also a master electrician and he has no training in mechanical maintenance (1025). Day-to-day supervision and decision making with respect to the maintenance of all rides and attractions in Fantasyland is Penn's responsibility (1029-30) (2212).

The third member of the senior management team in the maintenance area is Isaac Brower-Berkhoven, who was referred to as a supervisor. He reports to Penn and also to Keur (1025). Brower-Berkhoven's background is in electrical engineering with the Canadian Navy (2288), and he also has no mechanical experience (2295). When he first joined Fantasyland on December 1, 1985, Brower-Berkhoven's primary responsibility was for the submarine ride. He did not become involved with the roller coaster until February of 1986 and even after that time spent approximately one-half of each day with the submarines (2289-90). His responsibilities included setting up a planned maintenance program for the Fantasyland rides and attractions (2291) (2295).

B.K. Maintenance is divided into departments by trade, with different departments responsible for different aspects of the maintenance work. The electrical department is responsible for all electrical aspects of the rides and attractions. Penn, in addition to being the manager of the entire maintenance division, is also the head of the electrical department (Ex. 104) (1024-5). The mechanical department is responsible for maintaining the mechanical components of rides and Brower-Berkhoven is the head of that department (1024). The steelworkers, led by Stuart Houston, are responsible for the structure of the Drop of Doom and the roller coaster. The fourth department is electronics; it is responsible for computer electronics and solid state components of the rides.

As the initial start-up period was completed and regular operation of the ride commenced, equipment adjustments had to be made. The speed of the train is limited to a range between prescribed maximum and minimum values and this is controlled by adjustment of the side and bottom wheels in the bogie assemblies. This adjustment proved to be an area of some difficulty for the maintenance staff. Likewise, adjustment of the speed reduction brakes in the ride required attention by staff. In both of these areas, the initial responsibility was assigned to the mechanics.

After April 6, 1986, responsibility for making adjustments to the side and bottom bogie wheels of the trains and to the speed reduction brake was shifted from the mechanical to the electrical department (2084-7) (2094-9) (2194-7) (2459-62). The reasons for the change were that the electricians were more successful in making the adjustments, and Keur ordered the reassignment (2195-7). Penn described this as a "team approach" to maintenance (1145). There was evidence that at least one mechanic, Maleszewski, was unhappy that electricians were doing what he felt was essentially mechanical work and this caused some tension between the departments (2084) (2459-60) (2322).

An emerging problem during this period was that the "bandages" or tires for the running wheels were wearing much more quickly than anticipated; different solutions to this problem were explored (3517-9) (2285-7). As well, it was discovered early in the operation of the roller coaster that the bearings in the side and bottom bogie wheels had been fouled with sand during the operation of the ride over the Christmas period and these bearings were all cleaned or replaced (943-4).

When the roller coaster went into regular operation after March 15, 1986, the electricians and mechanics assigned to that particular ride began to do daily maintenance checks in the morning before the opening of Fantasyland to the public. They followed the Maintenance Manual (Exs. 9 and 90) in determining which checks were required (1945). Generally, the daily checks of the roller coaster began with maintenance personnel walking the floor under the ride to check for any unusual items that would raise any concern with respect to the roller coaster. Mechanical and electrical personnel did their respective checks during the early morning hours, working cooperatively. Mechanical personnel would check the trains from underneath. Prior to May 21, they examined the cap screws on the vertical axle assemblies on a monthly basis, but after May 21, this examination formed part of their daily inspection procedures. In addition to the checks on the outside of the train, the operation of the lap bars was examined. Electrical personnel would run the trains around the track, during which time they would check safety and reduction brakes, the up-drive and other electrical systems.

Between March 15 and June 14, 1986, the maintenance personnel responsible for the roller coaster were gaining experience in the maintenance of the ride. The following record-keeping and other documentation was developed:

(i) A single log book for the track and all six trains (Ex. 91);

(ii) A sign-off sheet to record that the various daily maintenance checks had been completed (Ex. 82);

(iii) Interim or draft checklists for electrical work (Exs. 92, 93 and 94) (1047-9) (2213-23);

(iv) Daily time sheets of maintenance personnel (Exs. 95 to 97a);

(v) Testing summaries prepared by Stuart Houston relating to the track (Exs. 98 and 99);

(vi) Checklists for mechanical maintenance work were apparently in the preliminary planning stages, but as of June 14 they had not been put into use (Exs. 101 and 105) (1562-3) (1632-3) (2106) (2309-13) (2334) (2297-2300).

The Board heard evidence that Penn and Brower-Berkhoven reviewed the log book and sign-off sheets (2325-9), as well as the time sheets completed daily, in some cases in detail, by each maintenance person (2335) (1051). Between March 15 and June 14, maintenance personnel met as a group approximately three or four times, but apparently no notes or memoranda were prepared as a result of those meetings (1653). No procedure was in place for informing the following shift of what had happened in the previous shift (1593) (1652) (2257), or for giving maintenance personnel specific instructions with respect to daily, weekly, monthly or yearly checks required on a given day (2213) (1551) (1664) (1720) (1726) (2255). A schedule of regular inspections of the trains was established but never implemented (2240-3). At no time was a program of non-destructive tests developed for the roller coaster (934) (1127).

The Board concludes on the basis of the evidence that the vertical axle assembly was a critical component of the roller coaster. At no time was there a formal or written identification of critical components of the trains. Maleszewski testified that he knew prior to the accident how the vertical axle assembly worked and that the four cap screws holding the bottom of the keeper plate in place were critical components and, further, that he told this to everyone he trained (2122-3). However, Malbeuf, who was trained by Maleszewski, testified that he did not know prior to the accident whether the vertical axle assembly could lift out if the four cap screws came out (1618-9). On the other hand, Schlingmann stated that he knew simply from looking at the assembly how it worked, but he did not discuss it with anyone else (1734-6). Brower-Berkhoven indicated that Stengel had told him there were no uplift forces during the course of the ride and, therefore, he understood there would be no problem if all four of the cap screws in the vertical axle assembly were removed (2316-7) (2298-2300). Penn stated at the Public Hearings that he did not know at that date how the vertical axle assembly functioned (1241-2).

Both Penn and Brower-Berkhoven indicated that the period from March 15 to June 14, 1986, was a very busy time for the maintenance personnel at Fantasyland.

> "Q. Mr. Penn, perhaps we could carry on while we are waiting for those copies to be made. Can you tell me who gave the instructions for the preparation of Exhibit 101?
>
> A. I did.
>
> Q. And to whom did you give those instructions?
>
> A. Actually to three or four people. Issac (sic) Brower, David Pipke, Lester Maleszewski, Howard Malbeuf. In other words, there was a meeting of the team.
>
> Q. When did you give those instructions?
>
> A. I could not be specific as to the date. As closely as I can recall, it was certainly in June. To be specific, I can't give you the exact date.
>
> Q. Was it after June 14, the day of the accident?
>
> A. To get our notes in the final state, quite conceivably it was.
>
> Q. You don't recall whether it was before or after the accident?
>
> A. I cannot, sir. I am sorry.

> Q. Mr. Penn, would it be fair to say that it was always your intention, as supervisor of the maintenance area, to have some documents like Exhibit 101 prepared with respect to the roller coaster?
>
> A. Yes.
>
> Q. Can you tell me why it wasn't done prior to the time that it was done?
>
> A. It was just in...it was still in the state of preparation. We had a new park on our hands, and we had new rides to deal with, and to develop a maintenance schedule for." (1063)

Brower-Berkhoven's evidence was as follows:

> "Q. And were these put on paper prior to or after the commencement of the operation of the ride?
>
> A. They were done, on the paper that we are using, after the commencement of the rides.
>
> Q. And why was that? Why wasn't it done before?
>
> A. Because prior to that, we were...we didn't have time to do...these things, are we talking about? They were all in the books, and we were using the books [ie. the Maintenance Manual, Ex. 9 and 90]." (2296)

> "Q. You say you use [Ex. 95-97] in formulating the planned maintenance system?
>
> A. This is the system that we would use. We have only been in business a short time. We haven't had a chance, yet, to make a long term plan." (2336)

On April 18, 1986, John van den Brande, who was one of the two mechanics trained by the Schwarzkopf GmbH representatives during Christmas of 1985, left the employ of B.K. Maintenance (2562).

Key evidence in the area of maintenance of the vertical axle assembly was given by the following mechanical maintenance personnel:

(a) Lester Maleszewski - trained as a machinist and had previous amusement park experience. He observed manufacturer's representatives operating the ride during Christmas of 1985. Maleszewski trained Malbeuf, Steen, Potvin and Upton, among others (2965-6). Prior to April 6, 1986, he sometimes did the daily checks on the roller coaster but he was not primarily responsible for that ride (2092);

(b) Howard Malbeuf - background in maintenance of heavy equipment. Malbeuf was trained on the roller coaster in late April of 1986 by Maleszewski and he subsequently trained Schlingmann, among others (1534);

(c) Herb Schlingmann - qualified Millwright with prior mechanical experience. Schlingmann started with B.K. Maintenance on May 3, 1986 and trained on the roller coaster with Malbeuf for approximately one week (1703-4);

(d) Dave Upton - qualified Millwright and lead hand from the beginning of June, 1986. Upton's area of responsibility did not include the roller coaster (2355-6) (2421) but he did the daily checks on the roller coaster on four occasions in total (2358);

(e) Stuart Houston - steelworker. Houston was previously employed by Canron Inc. for ten years and was involved in the erection of the structure of the roller coaster. He subsequently joined B.K. Maintenance to head its structural maintenance department.

Prior to May 20, 1986, Howard Malbeuf was primarily responsible for performing the daily mechanical checks on the roller coaster. It was his practice (1550-1) first to walk the floor under the roller coaster for ten or fifteen minutes (1663). He would supervise the greaser working on the ride and check with the electricians to determine their schedule of inspections for the roller coaster that day. Malbeuf would then inspect the train parked in the service area, looking at both the outside and underneath the cars. When that inspection was completed, another train would be moved into position in the service area. Malbeuf checked the four cap screws in the keeper plate on the bottom of the vertical assembly from underneath the cars (1559-61). It was his practice at that time to do a visual inspection of the four cap screws on a different train each week, on a rotation system. He kept no written record of which train was inspected on a given date, relying instead upon his memory of previous inspections. It took Malbeuf four to five hours to do the daily check on the roller coaster (1577-8). He understood that other mechanical maintenance personnel did the same thing (1562). He did not take a copy of the Maintenance Manual (Ex. 90) with him to do the inspections (1654-5). Malbeuf stated that it was his responsibility alone to check the trains (1635-6) (1645-7).

The purpose of the roller coaster was to give people a thrill by transporting them at high speeds with sudden accelerations down steep inclines and around sharp curves, and both the machine and its passengers were subjected to extraordinary and abrupt changes in forces and stresses. The persons who assume the responsibility of maintaining such a machine should exercise a particularly high standard of care in maintenance to protect the public who are invited to experience these thrills. The Board does not consider that the maintenance of the roller coaster in Fantasyland was up to such a standard.

Anyone's business, if subjected to the detailed examination of a Public Inquiry, would disclose inadequacies or imperfections where some things could have been done better or differently. In any business there will always be some situations in which an employee may differ with management as to the best way of dealing with a particular problem. These matters must be borne in mind in assessing the importance or weight to be attached to any particular item of evidence before the Board in the matter of maintenance. The Board has endeavoured to do so.

It is the Board's opinion that before the roller coaster commenced operations in March of 1986, an effective preventative maintenance program should have been in place to ensure that the machinery would operate safely and continue to operate safely. Maintenance management should have identified and understood all critical components, developed a program to check and service such components, and had checklists in place so that the mechanic would perform each item on the list and take responsibility for doing so by completing and initialing the form. There were several months while the coaster was on order, being assembled, test run and commissioned when this could have been done.

The roller coaster operated daily for three months prior to the accident with no mechanical checklists in place. A mechanical checklist was completed within days following the accident. Prior to the accident, the mechanics were instructed to follow the requirements of the Maintenance Manual. Each mechanic, in his own discretion, followed different procedures based on his reading and interpretation of the Manual and his understanding of verbal directions given to him. Management relied on the skill and common sense of individual mechanics who did not have specific experience with amusement park facilities or roller coasters. Maintenance procedures were evolving and improving, but by the time of the accident they had not attained as high a standard as should have been in place prior to the ride commencing operation.

Some brief comments with respect to the maintenance documentation in place are in order:

(1) Exhibit 82 - Operations Sign-off Sheet - the top portion of this document contains four categories which would be checked off by maintenance personnel prior to the start-up of the roller coaster each day. The document is useful from an operations point of view and is a good procedure for the operations personnel for the purpose of ensuring that maintenance personnel had done the daily checks necessary. It is not, however, of any assistance in determining specifically what maintenance

work was done on a given day, nor does the Board feel that that was its purpose. There are several instances where the four categories at the top of the document were not checked off.

(2) Exhibit 90 - Maintenance Manual - three copies of the Maintenance Manual were marked as Exhibits (Exs. 8, 9 and 90). Exhibit 8 is a German copy of the Manual, Exhibit 9 is apparently the version used by the electricians, and Exhibit 90 is an English translation which was delivered to Elevators and Fixed Conveyances Branch immediately after the accident. Exhibits 9 and 90 contain no translation of pages 1 to 27 of the drawings attached to the document and there are other portions that are not translated.. Although there are portions of the Maintenance Manual in which the translation may well not be precise, we are satisfied that Exhibit 90 is a relatively accurate translation of the Manual.

In some instances, the Manual is not clear and precise. In dealing with the vertical axle assembly, the Manual is not sufficiently specific with respect to the maintenance of the keeper plate and cap screws. There is no mention of the use of any thread adhesive material and the type of inspection is not specified, although the torque moments for cap screws of this particular size are given. Without any further information it might be reasonable to assume that an inspection of the cap screws in question would involve checking the torque. However, the evidence disclosed that B.K. Maintenance was advised verbally of the use of a thread adhesive, and this would be inconsistent with an inspection involving a torque check of the cap screws through the use of a torque wrench. It is reasonable to assume that at some stage the particular component would have to be disassembled and instructions should have been given as to the re-assembly of the component.

(3) Exhibit 91 - Maintenance Log for Roller Coaster - the Log Book was used for the roller coaster from March 29, 1986 to June 14, 1986. The evidence of maintenance personnel varied to some extent as to what was to be put in the Log Book. In most instances, the Maintenance Log is not sufficiently detailed to identify any particular problem as relating to a specific train or car or other component, and therefore does not create a meaningful history for different components of the ride. A good example relates to the replacement of the tires on the wheels. There is reference to such work being done in the Log Book but little or no indication as to which train or car is concerned. The result is that maintenance personnel or management could not identify whether excessively worn tires occurred with respect to

one train or another, or with respect to a bogie assembly that had bronze bushings as opposed to steel roller bearings, or other information of that nature.

The Board recommends that there be a more distinct identification for each train for the purpose of being able to differentiate easily between the trains. In this regard, a different color for each train would be useful, although a large number on the side of each car of each train would perhaps suffice. The Board also feels that a separate Log Book should be maintained for each train, so that if problems are reoccurring with respect to one train or another, they can clearly be identified. Consideration might also be given to separate Log Books for other components of the roller coaster system.

(4) Exhibit 92 - Checklists for Electrical Maintenance Personnel - these documents were prepared by Pipke and Mrochuk with respect to electrical maintenance. Pipke's evidence was that he did this at his own instance (2507).

(5) Exhibit 93 - To Do List for Roller Coaster - this document was prepared by Pipke to list those items requiring maintenance and specifically refers to electrical maintenance.

(6) Exhibits 95 to 97 - Daily Time Logs - the daily time records were initially prepared in handwritten form by the particular maintenance employee and later transcribed by the Accounting Department into what became Exhibits 95 to 97. The descriptions of work contained in Exhibits 95 to 97 are similar to those contained in the Maintenance Log Book (Ex. 91) and the same comments are to some extent applicable. The maintenance personnel themselves indicated that they did not have reference to or use these documents subsequent to their preparation and understood that the documents were prepared for accounting purposes only. The supervisor of the mechanical maintenance area, Isaac Brower-Berkhoven, indicated that he did review the documentation after its completion by the maintenance personnel (2335).

(7) Exhibits 98 and 99 - Testing Summaries Prepared by Stuart Houston Relating to the Track - Houston prepared a fairly detailed test summary with respect to the track and cap screws on a monthly basis. That summary does identify particular areas of concern and does provide the type of history with respect to the track and cap screws that would be necessary to identify a problem properly.

With respect to the general maintenance area, the Board recommends that B.K. Maintenance retain a consultant with expertise in preventative maintenance to review and make recommendations on the maintenance program established at Fantasyland and improvements that could be made to that program. Such review could consider the management, administration, identification of critical components, training of personnel, preparation of checklists, and any other matters that he considers appropriate with respect to the development and implementation of a preventative maintenance program.

B. MAINTENANCE - SPECIFIC ITEMS

1. Incident of May 20 Cap Screw

On the afternoon of May 20, 1986, Alan Mrochuk, an electrician with B.K. Maintenance, found a portion of a cap screw on the floor between the loading and unloading stations (Ex. 168) (2243). The head of the cap screw was painted red and, since there was a red train in Station Area 1 at that time, Mrochuk and Dave Pipke examined that train to see if they could find where the screw had come from. Mrochuk testified that, although he examined the red train, he did not know at the time that there was a connection on the underside of the vertical axle that used cap screws. The screw was given to Glenn Steen, the mechanic on duty, and Steen then looked for the location from which the cap screw had come. Steen was not normally involved with the roller coaster, although he had been shown how to adjust the side and bottom bogie wheels (3184). Steen testified that he checked the keeper plate at the top of the vertical axle assembly because he knew that cap screws of that size were used there. However, Steen said he did not realize that there was also a bottom keeper plate, and he did not look in that location for a missing cap screw (3186). Steen testified that he spent "a couple of hours anyway" looking for the location of the missing screw (3186-7).

After the unsuccessful search by Steen, the screw found its way onto the desk of Isaac Brower-Berkhoven (2266). On May 21, 1986, Howard Malbeuf was asked to find out where the broken cap screw had come from (1613). He quickly determined that it came from the lower keeper plate of the left bogie on the rear car of Red Train No. 4 (1661). Malbeuf and Pipke discussed the matter with Brower-Berkhoven and it was decided to remove that train from service and to check the other trains (1614). Yellow Train No. 1, which was not being used at this time and which was on a siding track, was put into service to replace the red train (Ex. 82). Malbeuf put the broken red cap screw in a locker in the coaster repair shop and nothing further was done with that cap screw (1615). No work was done on Red Train No. 4 between the time it was taken out of service and the date of the accident involving Yellow Train No. 1 (1621) (1169). The incident was not reported to the Elevators and Fixed Conveyences Branch, and there is no reference to it anywhere in the maintenance records. Maleszewski was not informed that a broken cap screw had been found (2121).

Brower-Berkhoven testified that he considered at that time doing tests to determine why the cap screw had broken and that he could have called Dr. Bruce Ball or Schwarzkopf GmbH for assistance (2271). (Dr. Ball is a consultant metallurgical engineer who had been doing some work on the coaster track and support structure.) However, he and Penn decided to wait until they could get Red Train No. 4 into the shop and take it apart:

> "Q. Did you consider, at that time, doing any tests to determine why the bolt was broken?
>
> A. Yes, we considered that.
>
> Q. What did you decide to do?
>
> A. We decided to leave it until we took the train off the track and put it in the coaster shop.
>
> Q. Why did you make that decision?
>
> A. Because it is easier to work on the train when it is in the coaster shop, for one reason.
>
> Secondly, since it was a one-time occurrence, it seemed to be a rare incident, and I didn't consider out of 160 bolts, one having fragmented, that it was an area of really dire concern." (2268)

It was Brower-Berkhoven's evidence that, after May 21, he gave instructions to increase visual inspections of the four cap screws in question so that every bogie assembly on all four trains was inspected each day (2256).

Penn testified that he was told that a broken cap screw had been found and that it had been identified as coming from the vertical axle assembly (1093-5). He concurred with Brower-Berkhoven and Malbeuf that Red Train No. 4 should be removed from service. He did nothing further because Keur had said that this was a "hands off" area (1152) and Penn wanted to wait and see if this was an isolated incident or if it would happen again (1162). Penn was asked whether the procedure for examining the vertical axle assembly changed after May 21:

> "A. Well, the area was put under a little more scrutiny, as far as the daily examinations.
>
> Q. But am I also fair in saying that you never instructed any of your maintenance people, specifically, to commence or make a more regular or a daily inspection of that particular area on the rest of the trains?
>
> A. Not specifically, no, because we still had, and felt the assurance, that that was again a factory sealed area, if you would, and it was an area that, in fact, had never even been drawn up in the maintenance manual, documented in the manual, itself, as an area to be checked." (1171)

Later Penn testified with respect to the vertical axle assembly:

> "A. Yes, it was watched a little more critically, I would say.
>
> Q. Why do you say that?
>
> A. Well, because we wanted to define whether we had a single incident, or whether this

> was going to happen with any further degree on any of the other trains.
>
> Q. Who gave the instructions with respect to watching it more carefully?
>
> A. I believe, again, that was a team decision and quite possibly it was made as a team between Mr. Brower, Bercov (sic), and myself, and the mechanics." (1243)

Penn did not seek professional advice regarding the broken cap screw (1258). He stated that if they had found a second broken cap screw, "we would have called in factory representatives..." (1251).

Malbeuf testified that after the broken cap screw was found on May 20, Brower-Berkhoven told him generally to step up his visual inspection of the vertical assembly (1619). Malbeuf's recollection was that he did not receive any specific instructions regarding what new level of inspections was to be instituted. He decided on his own to do one train each day, or in other words, each train every four days. This was the schedule he followed between May 21 and June 14, 1986 (1620).

Herb Schlingmann started doing the daily checks on the roller coaster after May 21 (1706). He testified that he was told to check the cap screws in the keeper plate on the bottom of the vertical axle assembly as part of his daily inspection and he was not aware of any rotation system for the inspection of the trains (1706). He inspected all four trains every day (1721). The daily checks on the roller coaster took Schlingmann between one and two hours in total (1721), and on the same days that he did the daily checks on the roller coaster he was also responsible for doing the daily checks on other rides (1720). His procedure (1718) was to walk the floor under the roller coaster and check each train. He would check the outside from front to back and then check underneath the trains, including the four cap screws. He would also check the lap bars and seats. Schlingmann stated that he did the same checks every day and did not do weekly or monthly inspections (1726). Schlingmann testified that he did not know that a broken cap screw had been found on May 20 until he learned about the incident during the Public Hearings (1733).

Penn testified that he never observed or supervised an entire inspection program as conducted by the mechanical maintenance personnel (1166-8). Penn stated that he relied on the team to do the daily inspections. Before June 14, Penn was not aware of whether or how inspections were conducted on the bogie wheel assembly.

Keur, the President of B.K. Maintenance, testified that he did not learn that a broken cap screw had been found until after the accident on June 14 (897-901) (941). Keur did not know at the time of the Public Hearings who had decided to take Red Train No. 4 out of service (907) or if the other trains had been inspected after May 21 (901). He stated that he would not be advised of the finding of any broken cap screws (942).

Several of the experts who testified at the Public Hearings and others gave opinions as to what steps they thought should have been taken upon finding the broken cap screw on May 20. Werner Stengel stated that it is not uncommon for cap screws to break in amusement rides:

> "A. Yes, but if this ride would be my ride, I had fixed one screw in and then operate the train again. And if it would happen in a short time again, maybe the same screw or at the same place in this four, then I would ask by the manufacturer. Or if I had seen this screw was broken on fatigue or damaged by high strength forces, then I had give this screw maybe to a laboratory to check it. But I would not be scared about losing one screw there or a broken screw.

> Q. But if you did see that the screw was broken through fatigue you think you would have given it to an expert.
>
> A. Not by the first one, not by the first, because you have..by 500 screws it happens sometimes that you will find a broken screw. You have to know a little bit about the importance, but at this place, there are four screws. So if you miss one, okay, you have to stop the train that's correct and then you have to replace it. But let me repeat again, by my opinion, I have replaced this screw and have done the operation again." (5098)

Later in his evidence, Stengel testified:

> "Q. You've outlined a procedure, Mr. Stengel, that you would follow if you found a broken bolt, and I think it was to the effect that you would take that train out of service, replace the bolt, but you would not stop the ride, so to speak; is that a fair summary?
>
> A. That's correct.
>
> Q. Does it make any difference to you whether the bolt that is broken is broken by a torque..overtorquing or whether it's obviously broken by way of fatigue?
>
> A. If the bolt is overtorqued and it's sure it's overtorqued, then you know the fault. There is no problem at all because you know the fault, then you can place a new screw in and go ahead.
>
> Q. What about if it's..my question really is, does it make any difference to you or would it make any difference to that answer that you found or you were able to determine by looking at the bolt that it had failed by fatigue?
>
> A. If I had found the first bolt out, by my opinion, I would place the new one in and make the ride again. But I had watched this careful and not this new one, maybe the others, because my opinion is always

> you never will have four broken bolts at the same time.
>
> So, if I would have maybe in one week longer a new bolt broken, then that gives me more to pay attention to this problem, but not by the first one, and then no doubt I had asked the manufacturer of the ride, but I never would stop the complete ride for this." (5191)

And later:

> "Q. Would you change that procedure if you were able to determine that the break was caused by fatigue or not?
>
> A. Not by the first case, not by the first case, and even not by the second case. I would be very careful if I found in the same area..you know, were four bolts and each hole has a position maybe like a watch, and if I would found always by the last car the rear axle on the left side in the same position a broken bolt, then I would stop and would say, there must be a mistake..a systematical mistake. Because if you have the broken bolt at the same part..the same area and so on, then you have to be very careful." (5193)

Larry McLachlan, the Director of Light Rail Equipment for Edmonton Transit, stated that he would record an incident such as a broken bolt in a log book and contact the manufacturer immediately (3921).

In answer to a question on cross-examination, Arthur Breed, an expert witness, made the following comment:

> "Q. I take it, Sir, if you had a situation where one cap screw would come out or one cap screw would fracture, that would be an indication to you of the start of a catastrophic event?

> A. That would be an indication that something was afoot." (3971)

Gary Jacobson, the operations planning manager in charge of operations and maintenance at Calaway Park, was asked about the policy at his facility.

> "Q. Mr. Jacobson, do you have any sort of policy or procedure established as to what your maintenance people are to do if they find a bolt or a part of a broken bolt or a place where a bolt should be that it isn't? What steps does your operation take?
>
> A. Well, assuming that was to happen, the obvious thing is that the ride would be shut down. It would be investigated as to where that bolt came from. We would determine or try to determine why it happened. Get in contact with the ride manufacturer and look into the history, if there was any history, if it was then. This is basically all on an assumption that something like this has happened. If there was any history of this problem or a characteristic that has re-occurred in another coaster in another park, until we were satisfied through the manufacturer and ourselves that the nature of the problem, it wouldn't be until then that we would reopen the ride.
>
> Q. Would you do that with respect to any item that you found or only items that you find from an area that you might consider to be critical to the integrity of the ride?
>
> A. Well, certainly the..you know, if it's critical to the ride, you would want to investigate it, yes. If it wasn't, let's assume that it was a bolt off the Q line railing, certainly not, you know." (4187)

Chris Hoogensen, an expert witness, was also asked for his opinion in this area:

"Q. So if that bolt [Ex. 168] had been brought to your attention, what would you have done?

A. I would have said that there is a part which failed by, in this case, because I haven't seen the other bolts, I would have stated that it would be a failure which was initiated by a fatigue, and a very high overload because there is a large shear area.

Q. If you had been the owner, what would you have been instructing the owner?

A. Well, if I know that Lock-Tite would have been used, there is very little what you can suggest, because what are you going to suggest, torque the bolts? That's the first time..what I would have expected, that, for example, there would be no gap. There would be good and proper clamping force but some bolt for whatever reason it became untorqued, and this is why it failed.

So the logical thing could then be to say torque your bolts. But you can't say that because there is Lock-Tite there and as I mentioned that is one of the limitations of Lock-Tite because you are supposed not to touch them.

Q. So, if the train continued to operate, what would you have recommended?

A. Operate, I certainly would not operate the train, I would say drill them out and put a new bolt in it.

Q. What if that train is taken out, would you stop running the other trains?

A. If it was a bolt which failed, you couldn't take out or stop all the trains, you would just repair that train, because you have only one bolt failure.

Q. What would you do with respect to the other trains?

A. Certainly watch whether it's just an occasional occurrence.

Q. How would you watch?

A. You have only one way to watch, Sir, that is by visual examination." (5318)

And later, Hoogensen testified:

"Q. The scenario, I believe, was let us assume no gap, you were advised that there was no gap; let's assume that there was a proper fit; let's assume that there was a proper keeper plate.

Now, in that instance, if that sheared bolt had been brought to you, would you have closed down the whole operation of the roller coaster?

A. First, Mr. Agrios, as far as the assumptions are concerned, basically, if there is no gap, no improper fit, there is a torque, there is no failure. So, in that a bolt is brought to me and am I led to understand that these are the conditions, I would have a problem to relate that failure all together. Because I would understand, I would only go to the bolt, I would characterize the bolt and in that case, I suppose I may have said to the client, can you check these bolts, are there more bolts there. They would then probably have told me, well, these bolts are secured with Lock-Tite. Then, I very little can say that keep an eye on your bolts.

> Q. How would you keep an eye on those bolts?
>
> A. Well, by a regular check on the bolts. I think you are referring whether I would stop the train. I think you could not stop an operation for that, because you don't know what the significance is except for one bolt is falling out. But of course, you keep your eye on it and, well, you have a bolt which fell out so you are trying to see where it relates to. Now, that's all I can say." (5545)

Rod Karen, a supervisor with the Elevators and Fixed Conveyances Branch, was also asked to comment on the finding of a broken cap screw on May 20. He testified as follows:

> "A. I don't think I would have ordered the ride to be shut down. I may have ordered that train to be shut down and checked; and viewing the results of the check, possibly all the trains checked.
>
> Considering the results we did get when we checked the rest of it, we probably would have ordered it all to be shut down and checked out. It's pretty hard to, it's a lot easier to assess the situation in retrospect than predict what you might have done. It would all depend on the circumstances at the time." (1518)

John Hinde is a witness who acts as a consultant in the amusement ride business. He has worked in that industry for a long period of time and some of his experience has been in the area of maintenance.

Hinde testified that, upon discovering a single broken cap screw like that found on May 20, he would order the entire ride to be shut down and then conduct a visual inspection of the area from which the screw came, including all trains. Upon completion of the inspection, and assuming that no additional failed cap screws were discovered, he would allow the trains other than the one from which the cap screw came to be restarted. He would then have ordered disassembly of the keeper plate and the cap screws and done a visual inspection of the assembly. If no other cap screws were found to be loose or sheared, he would not have consulted an expert. Continuing visual inspection was recommended for a short period of operation (5875-78). Further questioning indicated that Hinde's examination of the assembly would have included rough measurement of the parts and comparison of those measurements with the prescribed values on the shop drawings (5940). When it was pointed out that disassembly of the bogie connection on Red Train No. 4 would have revealed that, in addition to the fractured cap screw, another screw had zero torque, Hinde stated that he would advise a visual inspection on all trains in order to see if there was a "pattern" of this type of problem. Only in the event that another sheared or loose fastener was found would he have contacted the manufacturer (5939).

The Board notes that although Hinde has considerable experience in maintenance, he has no technical training and did not hold himself out to have any engineering expertise (5809).

Frank Dillon has fifteen years experience in the amusement ride industry and his experience includes the area of maintenance. He testified that if the discovery of a broken cap screw had come to his attention, he would have ordered a visual inspection of that critical area in all trains but then allowed the trains to operate if no other broken screws were found. The train from which the broken cap screw came would remain out of service until the assembly was broken down and the failed screw replaced. All trains would be examined visually until either it was decided that no further problems existed or a re-occurence of the problem showed up (6069). Dillon also responded to the possiblity that, in addition to the fastener that had fractured, another fastener of the group of four was found to have zero torque. He stated that this discovery probably would not have changed his suggested response (6093). Dillon said:

> "You have to be able to determine if there is going to be a pattern established and, believe me, if the next day you find that another bolt has backed off or fractured then yes, that is an indicator that you have to take it a step or two further" (6094).

For anyone with a reasonable amount of experience with mechanical fasteners, the most logical choices for an explanation of the fractured cap screws would be that the screw was sheared off, had failed as a result of a tensile overload, had failed in fatigue, or had been twisted off upon installation as a result of over-torquing. An even more knowledgeable person in this area of expertise, observing that the cap screws were made of high-strength steel and were galvanized, would include the possibilities of failure due to hydrogen embrittlement or stress corrosion cracking. Thus, there were at least six possibilities that had to be considered.

Shear failures in mechanical fasteners are easily identified. They have a characteristic failure surface that results when forces acting transversely to the longitudinal axis of the screw produce rupture. On the other hand, failures due to fatigue or as the result of a tensile load are the consequence of forces acting on the screw parallel to its longitudinal axis. Fracture due to stress corrosion cracking or due to hydrogen embrittlement are characterized by a lack of ductility and occur at right angles to the longitudinal axis of the screw. Twisting the screw off as a result of over-torquing produces a torsional failure. The ability of an experienced person to distinguish visually, or at least with the aid of only low-power magnification, among failures resulting from over-torquing, fatigue, tensile overload, hydrogen embrittlement, and stress corrosion cracking will depend upon the level of experience of the observer and the circumstances of the failure. In the most likely situation, that observer, having made a preliminary assessment, will want to subject the failed screw to a more detailed, laboratory examination. This will probably include examination using high-power magnification and use of a scanning electron microscope.

Both Arthur Breed and Werner Stengel examined the fractured cap screw that was discovered on May 20 (Ex. 168) on the basis of a visual inspection only. Breed's terms of reference as an expert witness did not include a detailed examination of the screw since that was being done by others. He examined the screw only at the time of his testimony during the Public Hearings. When Stengel visited the accident site on June 15, he became aware that there was a cap screw missing from the vertical axle assembly of Red Train No. 4, but the location of the fractured cap screw was unknown at that time (Ex. 211). As in the case of Breed, Stengel was shown the fractured surface of the cap screw in question only at the time he gave testimony before the Board.

Upon being shown the fracture surface and the adjoining short portion of the failed screw from Red Train No. 4, Stengel's testimony at the Public Hearing was as follows:

> "Q. That's the bolt that you expressed interest in. Had you seen that then or now that you see it, based on your experience over 20 years in the industry and seeing all of the broken bolts that you've indicated earlier that you've seen, are there any conclusions that you feel comfortable making based on that experience?
>
> A. By my opinion, this is a fatigue, you can see rest lines here and it's going on and

> then the last part is -- it's a force brake (sic), the last part. It indicates for me fatigue." (5133)

Thus, Stengel had no difficulty in coming to a conclusion with respect to the failure of that cap screw; he said that the failure occurred by fatigue, with the last part of the fracture surface showing failure by overload of the reduced cross-section.

Arthur Breed testified that he had examined the broken screw and concluded as follows:

> "Q. Your observations, did they lead you to any conclusion?
>
> A. They lead me to the conclusion that the failure was a fatigue failure.
>
> Q. How do you determine, Mr. Breed, whether it's a fatigue failure or not?
>
> A. By the fracture face, by examination of the fracture face.
>
> Q. What is it about the fracture face that tells you whether it's a fatigue break?
>
> A. Well, the mounted piece bears a fracture face and it is fairly obvious, even visually, that there are apparently, what are called beach marks, that looks like the waves on a beach, they're crescent shaped and they work their way until there is a substantial part of the screw that has actually got a crack across it. At that point, there is a catastrophic finish and the bolt has completely failed." (3596)

Thus, the testimony of both of these individuals, each of whom had considerable experience in the examination of mechanical fasteners, was that the screw that was found on May 20 had failed as a result of fatigue. These opinions were based only on visual examination of the screw.

Those experts whose duties had included a detailed examination of the May 20 failed cap screw were Hamre, Wayman, and Hoogensen. Each of these individuals has had extensive training and experience in the examination of fracture surfaces at the metallurgical level. In the case of the examination of the failed screw, each of these individuals examined the screw both with the aid of an optical microscope and using a scanning electron microscope.

Both Wayman and Hamre came to the conclusion that the cap screw failed as a result of fatigue. As described in Technical Issues, they reached this conclusion both in their original reports to the Board and in a subsequent re-examination requested by the Board. In his initial submission, Hoogensen took a position that appeared to differ somewhat from that of Wayman and Hamre. However, in testifying he agreed that his description of the fracture surface (failure due to an overload) could also be called "low cycle fatigue" (5311).

Based on all of the evidence, the Board is of the opinion that the fractured cap screw discovered on May 20 failed as a result of fatigue.

The technical significance of the finding of the broken cap screw and the type of failure that had caused that screw to fail is twofold. First, a failure had occurred in a portion of the train whose integrity was essential to the safe operation of that train. If all four cap screws were missing or had fractured, it can be assumed that the car would leave the track within one circuit. Second, the type of failure that had occurred was a fatigue failure. If fatigue failures occur, they are almost always associated with a relatively large number of load cycles. The screw that had failed in Red Train No. 4 was in the exception class; it almost certainly failed under a very low number of load cycles. It cannot be known with certainty what that number was, but Wayman said that "... it is estimated that the bolt had undergone approximately several thousand load cycles (less than 10,000) as the crack propagated prior to failure" (Ex. 217, Appendix C, p. 2). Hoogensen also was clearly of the opinion that the number of load cycles had been extremely low, and the evidence from the operations records of the trains was that Red Train No. 4 had operated only about 3700 trips, between April 3 and May 20, 1986 (Ex. 82).

In addition to the fact of the fractured cap screw discovered on May 20 and the implications thereof, the condition of other similar cap screws in the trains must be noted. It has been established elsewhere in this Report that a great many of the cap screws in the lower keeper plate connections throughout the trains were not in proper condition. There are a total of 240 cap screws of this type in the lower keeper plate connections of the six trains. A total of 148 cap screws were examined at the site for various features (Ex. 217, Appendix D). Twenty-nine of the 148 cap screws had a torque value less than the torque value of 69 Newton-metres prescribed by the installation requirements. Twenty-four cap screws were removed from the site for further examination. Of this group, six cap screws showed evidence of fatigue cracks, including one of the four cap screws which fell out of Yellow Train No. 1 and the two fractured bolts from Red Train No. 4 (Ex. 217, Table 1).

The evidence before the Board is that following the discovery of a broken cap screw on May 20, 1986, the location from which the screw came was determined within a reasonably short period of time. The discovery was brought to the attention of some of those in authority in the maintenance group, but the incident was not recorded nor was it brought to the attention of the Elevators and Fixed Conveyences Branch. There is evidence that those in authority who knew about the broken screw (Penn, Brower-Berkhoven) had no appreciation of the importance of the screw in the vertical axle assembly. Apparently, orders were given that there be increased surveillance of the type of connection from which the screw had come, but it seems that these orders were understood differently by various people, and not received at all by others. Certainly there was no protocol set out whereby it could be established by anyone who needed to check as to what was being done, the frequency of the inspection, and so on.

A number of witnesses gave testimony as to what they might have done if presented with the broken cap screw that was discovered on May 20, 1986. Clearly, views varied. One (Jacobson) would have shut down his ride at Calaway Park in this circumstance, contacted the manufacturer, and re-opened only when satisfied that the problem had been resolved. The Board notes that the coaster at Calaway Park has only one train. For an operation like Triple Five's, others (Stengel and Hoogensen) would have shut down the ride, replaced the broken screw, and then run the trains with increased visual inspection. Hinde and Dillon would have added disassembly of the key connection to the procedure suggested by Stengel and Hoogensen. Breed expressed concern, but did not provide specifics. McLaughlin stated that he would record the incident of a broken cap screw and contact the manufacturer, and Karen said that he would make a decision as to whether to shut down the other trains upon examining the critical one. No one suggested that professional help be sought, although it is noted that both Stengel and Hoogensen could be considered to be professionals within the area of examination of fractured cap screws.

Although a total of eight witnesses testifed as to their reaction to the discovery of a fractured cap screw, only a few of them can be said to be representative of the amusement ride industry. Clearly, Hinde, Dillon, and Jacobson do fall into that category. Stengel is very knowledgeable about amusement rides, but his high level of expertise cannot be expected to be encountered very often in the amusement ride industry. Breed and Hoogensen are technical experts with no direct involvement in this industry. McLaughlin is responsible for the maintenance of rolling stock that has strong similarities with amusement rides, but that is not the industry for which he works. Karen is a supervisor for Elevators and Fixed Conveyances Branch of the Alberta Department of Labour. He has significant experience with amusement rides, but it is derived from an inspection point of view.

Recognizing the limitation of this evidence before it, the Board is prepared to accept that the minimum response of those in the amusement ride industry, faced with the discovery of a fractured cap screw like that found on May 20, would have been simply to cease operations while a visual inspection of the problem area was made, and then to put all trains except the critical train back into operation and to increase surveillance of the operating trains. B.K. Maintenance met this definition of an industry standard in their response to the discovery of a fractured bolt on May 20, 1986; they removed the red train from service and ordered increased inspection of the other trains. If the definition of the industry standard can be extended to include disassembly of the connection from which the fractured screw came, as suggested by some of those examined, then B.K. Maintenance did not meet this criterion. However, the Board is of the opinion that disassembly of the connection by maintenance staff would have been unlikely to have disclosed the defects in this vertical axle assembly.

The Board does suggest, however, that the maintenance staff and their supervisors should have recognized that they were dealing with a critical connection in a relatively sophisticated ride; that they had only the experience of seeing the ride operated by others for a period of about two weeks and operating it themselves for a period of about three months; and that their Maintenance Manual contained instructions which were sketchy in some cases. The Board is critical of the maintenance operation for not having a protocol established whereby a proper inspection procedure was outlined and available to all of those who could possibly be involved. The Board recommends that in the future the discovery of a fractured fastener be communicated to the Elevators and Fixed Conveyances Branch of the Alberta Department of Labour. The Board does not place upon B.K. Maintenance the onus of calling in an expert opinion as to the possible cause of the failure because the evidence concerning the industry standard in such a case does not support such an onus.

In the opinion of the Board, if an industry is prepared to conduct only visual examinations and to wait until a "pattern of failures" develops following the discovery of the failure of a fastener in a critical connection, it is not setting a sufficiently high standard. For example, in the vertical axle assemblies of the Triple Five trains, neither of the two mechanisms for ensuring the integrity of the fastener, preload and the presence of a thread adhesive, can be inspected visually in any worthwhile way. A visual inspection would be likely to reveal only grossly loosened cap screws. Furthermore, no visual inspection could have identified that there were cap screws with fatigue cracks in the fasteners of these connections. Concerning the discovery of the fractured screw on May 20, the Board is of the opinion that any reasonably informed expert would have quickly identified that the failure in question was not one resulting from installation, that is, it did not result from over-torquing. Thus, a cause of failure resulting from operation of the coaster or as the result of a deficiency in manufacture of the screw was indicated. The evidence before the Board is that the cause of the failure in that case (fatigue) was easily identified by those with experience. The Board considers that the discovery of a fatigue failure in a fastener that had been subjected to load in a train that had run only about 3,700 circuits was cause for alarm and further investigation. Any further investigation would have revealed quickly that another screw in the same connection had zero preload and that another screw in the same train had also fractured. Thus, for the cost of a relatively simple inspection by an expert, an opportunity for the identification of a serious problem that existed within the screws that fastened the lower keeper plates to the vertical trunnions was missed.

The Board recommends that, following the discovery of any unusual problem in a critical part of any amusement ride, all operations cease until that part has been examined by someone qualified to pass judgment and that person has made a recommendation as to the further operation of the ride.

2. Keeper Plate Screws

The loss of four cap screws from the keeper plate of a vertical axle assembly permitted a wheel assembly to fall off a coaster train; this caused the accident. Accordingly, a considerable amount of evidence before the inquiry related to the screws, and to their inspection.

The head of maintenance, Keur, understood the vertical axle assemblies were factory assembled with screws secured by a thread adhesive with the brand name of Loctite (992) (1012-13) (1015-16) (1018). Keur heard Anton Schwarzkopf remark that to loosen such a screw required the application of heat, and if an attempt was made to loosen such a screw without heat, either the wrench handle would break, or the screw head would break off (3535-7). Keur expected that his staff would not touch such screws and would only check them visually, at the intervals specified in the Maintenance Manual (982) (994).

The Maintenance Manual (Ex.9, p.17) provides as follows:

	Interval
All the screwed joints must be checked; after ca. 50 hours of operation, further checks in regular intervals	Yearly
Special joints must be checked in shorter intervals; these are axle joint, sword, brake blades, contact makers.	Monthly

The Fantasyland maintenance staff interpreted this part of the Manual to require monthly checks of the four keeper plate screws in each vertical axle assembly. Accordingly, during the first month or two of the coaster operation these screws were checked monthly (994) (936).

The supervisor of the maintenance staff in Fantasyland, Penn, testified that he understood the keeper plate screws to be "factory-proofed" (1097). He did not know whether the vertical axle could lift out of its housing if the keeper plate screws were removed, but he thought not (1241). Because the screws had both torque and thread adhesive applied, he stated this was an area for very little concern (1097-8).

Similarly, the supervisor of mechanical maintenance, Brower-Berkhoven, testified that he understood that all the forces on the entire track were downward (2317). If the four screws and the keeper plate came out on one bogie he expected that the train could continue to operate and nothing should happen (2274) (2277).

Until May 20, 1986, no mechanic had ever found a loose or missing screw from the keeper plate of a vertical axle. The head of a red screw was found on May 20, 1986, and on May 21 it was determined that it came from the keeper plate of a vertical axle assembly on Red Train No. 4. This train was immediately taken out of service (2266-7). The screw head was not examined to determine the cause of its failure (2268-72).

The failure of the screw was not recorded in the maintenance log (2279). It was not reported to Keur, who did not learn of it until after the accident (897-901) (941-2), and the maintenance supervisors showed very little concern. They still regarded the axle assembly as a factory secured area and the failure of the cap screw as an isolated occurrence (1162-3).

After May 21, 1986, the mechanics were requested to increase their inspection of the screws in the vertical axle assembly (2256) (1619-20). Some of the persons doing the daily checks knew that one of these screws had broken, but others did not.

Malbeuf testified that after the broken cap screw was found on May 20, Brower-Berkhoven told him generally to step up his visual inspection of the vertical assembly (1619). Malbeuf's recollection was that he did not receive any specific instructions regarding what new level of inspections was to be instituted (1620). He decided on his own to do one train each day or, in other words, each train every four days. This was the schedule he followed between May 21 and June 14, 1986. Malbeuf testified that he did the daily checks on the roller coaster on the morning of the accident and on the two previous days (1627-30). With respect to keeper plate screws, on June 14, he inspected a red train; on June 13, Yellow Train No. 2; and on June 12, a blue train. Malbeuf did not recall working on June 11 (1660) and he did not know which trains had been inspected prior to June 12 (1629). Until June 12, Malbeuf had not conducted any inspections on the trains since early June, which was the last time he was on the day shift (1649-51).

Herb Schlingmann started doing the daily checks on the roller coaster after May 21 (1706). He testified that he was told to check the cap screws in the keeper plate on the bottom of the vertical axle assembly as part of his daily inspection and he was not aware of any rotation system for the inspection of the trains (1706). He inspected all four trains every day (1721). The daily checks on the roller coaster took Schlingmann between one and two hours in total (1721) and on the same days that he did the daily checks on the roller coaster, he was also responsible for doing the daily checks on other rides (1720). His procedure (1718) was to walk the floor under the roller coaster and check each train. He would check the outside from front to back, and then check underneath the trains, including the four cap screws. He would also check the lap bars and seats. Schlingmann stated that he did the same checks every day and did not do weekly or monthly inspections (1726). Schlingmann testified that he did not know that a broken cap screw was found on May 20 until he learned about the incident during the Hearings (1733).

Schlingmann did the daily checks on the roller coaster, following his usual procedure, from June 7 to 11, inclusive, and did not observe anything unusual with respect to the vertical axle assembly (Exs. 91 and 97) (1753). It was Schlingmann's recollection that on June 12, he helped Malbeuf do the daily checks and that he, Schlingmann, inspected the vertical axle assemblies on every train at that time (1754-5) (1778-80). Schlingmann testified that he never observed any loose cap screws (1786).

Stuart Houston testified that he walked the floor under the roller coaster during the graveyard shifts of June 10 - 11 through June 13 - 14 and he did not find any cap screws from the roller coaster (3807-8) (3823-6) (4262). As well, Houston looked under the unloading station and did not see any cap screws in that area (3808-10) (3826-8). He stated that if cap screws had been on the floor between June 11 and 14, he would certainly have found them (3808-10) (4235).

Dave Upton, who knew that a broken cap screw was found on May 20 and whose inspection procedure was similar to

Schlingmann's, first testified that he specifically recalled doing the daily checks on the roller coaster on June 13 (2348-50). However, during the next day's testimony, Upton corrected himself and stated that he did the daily checks on June 11 (2368) (2429-30) with Schlingmann; Upton did the undercarriage of all four trains and Schlingmann did the rest (2415). Upton also testified that he did the daily checks on the roller coaster on June 6 (2357).

Elliott Potvin, a greaser who worked for B.K. Maintenance from March or April of 1986 to approximately June 10 (2630), testified that he also did daily checks on the roller coaster on occasion, sometimes with a mechanic (2664) and sometimes alone (2634-6). He was trained to do the daily checks by Maleszewski (2633). Potvin's procedure (2632-4) was to "eyeball" the train, inspect the wheels, do whatever greasing was necessary and check the lap bars. He did not sign Exhibit 82 when he did the daily mechanical checks because he was not a qualified mechanic (2645). Potvin testified that he received no instructions to check the vertical axle and therefore never did so (2654). When doing the daily checks with a mechanic, Potvin checked along one side of the train, while the mechanic did the other side (2664). There are no entries in the log book (Ex. 91) regarding Potvin doing the daily checks and the mechanics testified that Potvin did not do daily checks at all (1646-7) (1743-4) (2385). Potvin testified that he did the daily checks on the roller coaster on June 6 (2651). His recollection was that he had done so with a mechanic and he thought it might have been Schlingmann (2652). Potvin stated that he never did the daily checks with Upton (2652).

Wayne Storfield is the manager of the night cleaning crew responsible for Fantasyland, among other areas at West Edmonton Mall (1363-4). Storfield stated that his crew sweeps and mops the floor under the roller coaster once every one or two weeks. It was his recollection that the floor was last swept, mopped and pressure-sprayed on June 2, 1986 (1367).

Penn testified that he never observed or supervised an entire inspection program as conducted by the mechanical maintenance personnel (1166-8). He stated that he relied on the team to do the daily inspections. Before June 14, Penn was not aware of whether or how inspections were conducted on the vertical axle assembly.

The Board heard evidence from a number of witnesses relating to the methods used in inspecting the four cap screws in the keeper plate at the bottom of the vertical axle assembly and, specifically, whether or not a hand-held light was used during the inspections. The inspections were carried out with the trains parked on the rails in the service area between the loading and unloading stations. All of the witnesses agreed that in order to inspect the cap screws, it is necessary to get between the rails underneath the cars. Malbeuf testified that he only used a flashlight or trouble light if the natural lighting in the area was bad (1533) (1558) (1647). Schlingmann said that he never used a light while inspecting the cap screws (1723) (1762). Similarly, Upton never used a light (2355). Brower-Berkhoven testified that he always used a flashlight (2261). In his inspection after the accident, City of Edmonton Police Detective Strulick apparently used a flashlight (3278), and Griffin, the EFC inspector, testified that a flashlight would be beneficial but that it was possible to see the four cap screws without extra light (3264) (3303) (3339).

On September 24, 1986, the Public Hearings convened at the site of the roller coaster for the purpose of viewing the four cap screws in the keeper plate on the bottom of the vertical axle assembly. In addition, the members of the Board attended privately at the site on a number of other occasions and viewed the vertical axle assemblies. The personal experience of the members of the Board was as follows:

(a) the four cap screws in the vertical axle assembly can be seen by an observer standing between the rails of the track;

(b) the four cap screws are in a difficult position to inspect, and the inspection will not be effective unless done with care;

(c) the four cap screws can be seen better and more easily with a light and perhaps also with a mirror;

(d) the cap screws on a yellow train can be seen more clearly than those on the red or blue trains;

(e) it would be easier to detect movement of a cap screw using a system of matched marks on the cap screws and on the keeper plate;

(f) a visual inspection cannot determine preload of the cap screws or the effectiveness of a thread adhesive compound on the cap screws;

(g) certain apparatus located between the tracks sometimes contributes to the difficulty of viewing the keeper plate on a particular vertical axle assembly, depending on the position where the train is stopped.

In the opinion of the Board, it is unfortunate that of the people primarily responsible for mechanical maintenance of the roller coaster, no one person was aware of all of the relevant facts relating to the vertical axle assembly. Penn and Malbeuf knew that a broken cap screw had been found, but did not understand how the assembly operated. On the other hand, Maleszewski and Schlingmann, who understood how the assembly worked, were not aware of the broken cap screw. Upton apparently knew all the facts, but he was not primarily involved with the roller coaster.

In the Board's opinion, Malbeuf's procedure for inspecting the four cap screws was thorough and careful, and he likely would have detected a protruding cap screw or loss of a cap screw. However, the Board has less confidence in the effectiveness of the inspections conducted by Schlingmann or Upton.

The evidence before the Board indicates that at no time did maintenance personnel from B.K. Maintenance put a wrench on or otherwise work on the cap screws in the keeper plates of the vertical axle assemblies on any of the trains. With respect to the four caps screws involved in the accident, tests conducted by the R.C.M.P. Forensic Laboratory found no tool mark impressions on the paint on the heads of the cap screws (Ex. 217, App. A).

Prior to May 20th, the attitude in the maintenance department was that the vertical axle was factory assembled with its screws secured by a thread adhesive. The vertical axle was to be observed visually but not touched, and no one seriously expected to find any of these screws loose or missing. Since the commencement of operation of the roller coaster, maintenance personnel were not aware that any of these screws had loosened or failed. On May 20th, one of these screws was found to be fractured. In the opinion of the Board, this was a clear warning that a failure could take place in this critical component. Maintenance management should have ensured that all mechanics were made aware of the broken screw and of the necessity for increased care in the inspection of these screws. If maintenance management wanted daily inspections of the forty screws in the lower keeper plates of the ten vertical axle assemblies of each train, they failed to take adequate steps to inform their mechanics of this clearly and to ensure that such inspections were done.

Anton Abele was the German engineer whose firm prepared the shop drawings of the vertical axle assembly which the manufacturer followed when fabricating this assembly. He was asked for his opinion about the provision in the Manual requiring inspection of these screws once a month. Abele replied, in part, as follows:

> "I would never ever agree to the time of doing the tests only monthly. I think that is completely irresponsible to have such a long duration in between tests....But for this one specific part with regard to bolts, I do think that a monthly test is

> irresponsible because just due to the frequency of the rides on a daily basis, due to the speed and everything which this ride was operating, I just cannot understand why the duration between tests was so long....I would certainly recommend, and I would plead for it, that the whole train should be checked every single day....and particularly, these very critical parts of the train should be really checked every single day....I would certainly....first recommend that this should be a visual test, but this visual test should be done by a specialist, by an expert who really knows everything about this specific part of equipment." (4656)

Malbeuf did the daily mechanical checks on the trains on June 12th, 13th and 14th. By reason of maintenance management's failure to direct clearly that the keeper plate screws of every train should be inspected every day, Malbeuf inspected a red train on June 14th, Yellow Train No. 2 on June 13th and a blue train on June 12th. Schlingmann was on duty June 11th, when he inspected the keeper plate screws of all trains.

According to this evidence, the last certain inspection of the keeper plate screws on Yellow Train No. 1, the accident train, was conducted by Schlingmann on the morning of June 11th. Schlingmann gave some assistance to Malbeuf on June 12th and it was his recollection that he inspected the vertical axle assemblies. Therefore, the keeper plate screws of Yellow Train No. 1 may have been inspected by Schlingmann on that date. In any case, it appears that Malbeuf did not check the keeper plate screws of the accident train on June 12th, nor did he do so on the mornings of June 13th and June 14th. Yellow Train No. 1 operated from the 21st of May, 1986, to the 14th of June, 1986, about twenty-five days. At the end of that period, four cap screws from the keeper plate fell out completely, and the consequence was the accident that occurred on June 14. During that period, depending upon which mechanic happened to be on duty, the keeper plate screws were inspected either daily or every fourth day, with the last inspection being on the 11th of June or, possibly, on the 12th of June.

The evidence before the Board is that it was intended that these cap screws be secured in place by two methods. One of the methods was to induce a preload in the installed fastener by applying torque; the other was the use of thread adhesive. Consequently, any inspection can only be visual. A test to determine torque would break the thread adhesive and the second locking method would then be destroyed.

The loosening of a preloaded fastener as a result of vibration will take place in two phases. In the first phase, the preload will decrease from its installed value. Because the amount of elongation that is necessary to induce the preload is very small, relaxation of the preload due to gradual unturning of the screw cannot be seen visually. If thread adhesive is present, it must also be noted that for relaxation of the preload to occur in this fashion the bond introduced by the thread adhesive must be broken.

Once the preload has been decreased to zero, or at least to a very low value, it can be expected that the rate at which the screw will move out under vibration will increase substantially; both the locking methods have now been destroyed. It is to be expected that it is only during this second phase of the loosening of the screw that the amount of protrusion will be noticeable to the observer.

The preloaded screw is also protected against large increases in internal force as external forces are applied to the connection. As the preload decreases to zero, this protection is lost and the forces in the screw can rise substantially. The consequences of this can be failure by overloading of the screw or by fatigue.

In the view of the Board, the best possible way for B.K. Maintenance personnel to have observed the cap screws was to have started with match marks placed on each screw and the adjacent housing. In this way, it would have been possible to identify when the bond of the thread adhesive had been broken and the screw was starting to rotate out. However, the Board is not of the opinion that B.K. Maintenance should have been inspecting the screws with this degree of care. The only loosening that a reasonably prudent owner could be expected to detect is the loosening that becomes evident when a screw begins to protrude from its housing.

Dr. James Montgomery did a very thorough study of the accident and prepared a comprehensive report (Ex. 217). The following excerpts relating to the screws are taken from Dr. Montgomery's comments in that report:

> "There is no practical way to determine the number of trips that Yellow Train #1 made between the time the first M10 cap screw from the left bogie connection of the rear car loosened and the time the accident occurred. However, from consideration of the condition of components following the accident, we believe that it is possible to make inferences about the sequence of events which led to the failure." (p.50)
>
> "Police Exhibit E40 was likely the first cap screw to fall away from the connection. The threads of this screw appear to be undamaged..." (p.51)
>
> "We speculate that either cap screw Exhibit E27 or E73 fell away from the connection next". (p.51)
>
> "...Exhibit E48 was likely the last cap screw to fall away from the connection, and as such, it vibrated out rather quickly". (p.53)
>
> "...it is not possible to determine the number of trips required for the M10 cap screws to vibrate loose from the critical connection and cause the accident." (p.54)

> "From consideration of the failure sequence and number of trips made, we would speculate that the first cap screw most likely fell away from the connection in the days, or possibly hours, before the accident occurred." (p.55)

Other experts were in agreement with Montgomery that there was no practical way of determining how long it took for these screws to vibrate loose. Before Montgomery testified about clearance between the outer surface of the trunnion and the inner surface of the bronze bushing, Breed gave his testimony as follows:

> "Q. In your opinion, can you determine or can it be determined how long it would take for the four bolts to come out?
>
> A. Not any way that I know of. I can say that the first incident is a loosening of one bolt. That bolt then becomes either subject to fatigue type loading and fractures or proceeds on its loosening path within an operational time difference. From that occurrence to the start of the second might be one span, I don't have a blackboard, but it would occur within a time frame after the first occurrence, sometime within that point. Now, then the third failure would be sooner within a somewhat compressed time span; the fourth failure very shortly thereafter. The difference between the first and the second is longer than the second and third and longer than the third and fourth." (3963)

Werner Stengel prepared a report (Ex. 211) for Triple Five in which he concluded that for a screw to loosen and come out completely it would take several days, perhaps weeks, with dynamic shaking (5045-7) (5057). However when he considered the information in Montgomery's report indicating clearance between trunnion and bushing and wear on the inside of the bushing, he concluded that the screws might come out more quickly, but he could not tell approximately how long it would have taken (5094-

6). Hoogensen's conclusion was that the time it would take for bolts to loosen was unpredictable. He said he could not disagree with Montgomery's conclusion that they could come out in a few hours or a few days (5347-8).

Hoogensen conducted a test to determine how long it would take cap screws to come out of the vertical axle assembly as a result of vibration from the operation of a train (Ex. 265). One of the four screws was clean and the remaining three were greased. All four screws were touch-tightened and none of them had any torque or preload, so the conditions were very favorable for loosening. He made marks so that he could determine how much each screw moved. The train was run for eleven trips and the screws examined. The clean screw which had been touch-tightened showed no movement. The three screws which had been greased and touch-tightened had moved various degrees, the greatest being one-half a turn.

Hoogensen then ran the test a second time after touch-tightening all four screws and then loosening one of the greased screws slightly. He ran the train through five trips, and the greased screw which he had loosened had vibrated out completely and the remaining three screws were in place. Hoogensen considered that all he had proved was that the time for loosening was unpredictable (5346-7-8) (Ex. 265, p. 62-6). It took five trips or approximately half an hour for one screw to loosen under the very favourable circumstances of this test.

Hinde testified that a cap screw can vibrate loose in a period of time of minutes to hours to even days depending upon the forces (5878). He thought it was possible that all four cap screws could vibrate out in a few minutes. Hinde does not have a technical background and he is not an expert in vibration loosening.

The Board has considered all of the evidence and does not accept that all four cap screws came out in minutes. The Board concludes that the four cap screws came out in the days or hours before the accident and that each screw left the assembly at a different time.

If all screws appeared to be in place on the morning of the 12th of June, they vibrated out in the three days of operation on the 12th, 13th and 14th. It will never be known whether one or more screws were in fact vibrating out and beginning to protrude from the keeper plate on June 13 or 14, because no inspections were done on those dates. Maintenance management failed to make clear to its employees the frequency of inspection required, and the Board is critical of this failure.

After the accident the four cap screws were found in widely separated spots on the floor of the coaster building. The screw which Montgomery considered likely had fallen away first was inside a wall below the unloading station near the west side of the building. With respect to the two screws which Montgomery considered likely had fallen second and thirdly, one was found near the east side of the building beneath the track approximately 100 feet south of brake station No. 3, and the other was found near the north end of the building beneath the track after it had passed brake station No. 3. The screw which Montgomery considered likely had fallen last was found beneath the first loop of the double loop near the west side of the building.

The Board accepts the evidence of Stuart Houston that he walked the floor of the coaster building on 14 June, 1986, and did not find any cap screws. The Board has less confidence in his conclusion that because he looked and did not find, therefore nothing could have been there.

The floor of the coaster building covers a very large area. Concrete bases and steel columns supporting the coaster track rise from this floor, as do the concrete block walls beneath the unloading and unloading stations, and the structures of the two other rides. To view all of the floor one has to look on each side of every obstruction.

On Sunday, 15 June, 1986, in the morning following the accident, Karen and Millward, assisted by Mellors, police officers, and Griffen searched the floor for the four screws. They used a flashlight to inspect under the loading and unloading stations (3054). Three of the screws were found by Sunday noon. Karen and Millward searched again in the afternoon to double-check that nothing had been missed. When they went under the loading and unloading stations, and behind those stations, using a flashlight, they found the fourth screw which they had failed to find during their morning search (2997-9) (3054).

This screw was the one which Montgomery inferred likely fell first. If this screw was on the floor on the morning of June 14th, it is possible that Houston may have missed it, just as Karen, Millward, and the police missed it during their search on the morning of June 15th.

Expert opinion has been received with respect to the length of time that it might have taken for the four cap screws to vibrate out from the keeper plate. That opinion is that it could have taken "days" or it could have taken "hours". The expert opinion is that the length of time cannot be determined with any degree of precision. No inspection of these screws on Yellow Train No. 1 was made on the 13th or 14th of June, so what would have been found by such inspections can never be known. However, as the screws could have loosened and fallen out in "hours", the Board is unable to determine whether the failure to inspect contributed to the accident.

3. June 14th Noises

Fantasyland is a relatively noisy place with numerous rides in operation and crowds of people enjoying themselves. In addition to the usual sounds, on the night of June 14th, 1986 a rock band was also playing in the area. However, on that evening employees working on the roller coaster heard unusual noises that attracted their attention.

Cameron Kapty was an attendant employed at Fantasyland and he was taking tickets for the roller coaster ride that night. Around 7:30 that evening, which was about two hours before the accident, he heard noises coming from Yellow Train No. 1. The sounds were like scraping of metal, but these sounds are frequent (Ex. 132, p.7) (2924). Nevertheless, the sounds were different than any he had heard before and he heard them when the train was on the horizontal loops circling the Orbitron ride (2925). He heard the sounds from two different trips of Yellow Train No. 1 (2925). He discussed the sound with Dean Jordan, a loading attendant employed by Fantasyland who was working with him, and decided to notify the operator, David Smith (2926).

In Jordan's statement to the police, he mentioned that during the early evening he and Kapty noticed one of the yellow trains making a very strange noise when it went around two horizontal loops. These were not sounds that he or Kapty had ever heard before, so they alerted the operator (Ex. 131 p.2,3) (2904). He described the noise he heard as a clanking noise, like banging two pieces of metal together (2905). He heard it on two runs of Yellow Train No. 1 (2906).

David Smith was the operator of the roller coaster on the night of June 14th. He took a break from his duties at approximately 7:30 in the evening until 8:00. Shortly after he returned from his break, at about 8:10, he heard strange clanking noises (2839). The noises came from Yellow Train No. 1 (2840). He heard the noise when the train went into a slanted position on the spiral underneath the Fireball (2841). When the train went on the level, he could not hear the noise. Smith described the noise as a sound like metal hitting metal very quickly (2841). He heard the noise on two runs of the same train (2842). When he heard the noise the second time, he stopped the ride and did not allow any passengers to board while he waited for the maintenance man to arrive (2844).

Smith testified that the maintenance man on duty that evening was an electrician, Albert Zylstra. When Zylstra arrived, Smith informed him of what he was hearing. Zylstra asked Smith to load passengers on the train that was making the noise and run it again so he could hear the noise himself (2844). Zylstra listened while Smith ran Yellow Train No. 1 through the track on two occasions. Neither heard the noise and Zylstra advised Smith to continue operating the ride (2846).

Zylstra testified that he was employed at Fantasyland as a maintenance electrician. During the six months he worked there, he was employed mainly on other rides and he had assisted on electrical work with the coaster on only two or three occasions (2512-15). About 8:00 p.m. on June 14, Zylstra was called by the coaster operator to come and listen to a yellow train because the operator heard a banging noise as it went around the curves (2517). Zylstra gave a statement to the police (Ex. 125) which appears to state that he listened twice to the same train. At the Public Hearings, Zylstra testified at length on two occasions, and it appeared to the Board that there was confusion as to which yellow train he listened to with Smith. The Board is satisfied that Zylstra listened to a yellow train on two occasions about ten minutes apart and did not hear any unusual noise on either occasion (2518-20). Zylstra found it strange that the operator Smith could have heard a noise because the rock band was playing so loudly (2532). In any case, Zylstra heard nothing, so he advised the ride operator to continue operating the ride.

Three persons employed in the operation of the roller coaster heard unusual noises from a train which led them to close the ride temporarily and call for maintenance staff. In the opinion of the Board, to operate that train again so that an electrician with almost no training or experience on the coaster could try to hear the same noise does not appear to make any worthwhile contribution to the solution of the problem.

The Board is satisfied the noises heard by the operator and the two attendants came from Yellow Train No. 1. The unusual noise had been heard by three persons employed in the operation of the coaster who were familiar with its normal sounds. The operator quite properly ceased to load passengers, temporarily closed the ride, and called maintenance staff.

The maintenance man on duty was an electrician, and most of his training and experience in Fantasyland related to rides other than the coaster. Mechanics maintain the trains and they perform the daily mechanical checks on trains. There is nothing electrical on the trains themselves other than cosmetic items.

In the opinion of the Board, the train from which the noise came should have remained out of service until it could be examined by maintenance staff with training and experience in doing mechanical checks of the roller coaster trains. On this point, the Board notes the evidence of Jacobson (4185), as well as the evidence of Ken Glenn, Operations Manager for Fantasyland, as follows:

> "Q. And are they given instructions as to the re-starting of the ride Mr. Glenn?
>
> A. Yes, for the most part, the ride would be re-started by the Maintenance Department. Once all the guests have been removed, the ride would be thoroughly checked out

> by electrical and/or mechanical and then re-started and run for numerous times, depending on what the situation was, by the Maintenance Department, and then turned back over to Operations for opening to the public." (3441)

The Board is of the opinion that the noises heard on the evening of June 14 were related to the vibration loosening of the four cap screws. At the time that Yellow Train No. 1 was stopped by operator Smith, the Board concludes that although the keeper plate was still attached to the trunnion by one or more cap screws, it was loose enough to have created the noise that was heard by operators familiar with the normal operating sounds of the facility. The Board has concluded in any event that the four cap screws came out in the days or hours before the accident and that each screw left the assembly at a different time. Therefore, the Board concludes that if any mechanic with training and experience in daily mechanical checks of the coaster trains had inspected this train before it was put back into service, it is highly probable that he would have discovered the keeper plate to be in a loose condition with missing or protruding screws.

This Board is not critical of the maintenance man on duty, who had been given no clear directions or guidelines to follow. This Board is critical of maintenance management for not having had directives or guidelines in place.

Having regard to the normal problems associated with scheduling a limited number of personnel over lengthy hours of operation, it would not be an unusual situation for a maintenance man to be on duty who had little or no training and experience on a particular ride where a problem developed. However, in the opinion of the Board, it would be reasonable to expect management to have had guidelines or directives in place, particularly for the more sophisticated rides like the coaster in Phase II, providing something similar to the following.

When a problem arises relating to any vehicle unit or ride, test runs should not take place with passengers in that vehicle unit or ride until the cause of the problem is determined. In any case where operations temporarily removes from service any vehicle unit or ride pending inspection by maintenance, it should not be put back into service until it is established by someone competent to make the decision that it can be reopened safely.

XII. LEGISLATION AND REGULATIONS

INTRODUCTION

The Board of Inquiry was instructed to inquire into and report on the adequacy of existing Alberta laws, regulations, rules and standards governing amusement ride operations and safety. The principal interest of Governments in amusement rides is public safety.

Accidents do occur on amusement rides. In 1983, a committee on Amusement Ride Safety reported to the California legislature that during the year 1981, there were 14,000 personal injuries reported on amusement rides in the United States, of which total 300 occurred on roller coasters, and seven of the total were fatalities.

The California Committee found that fifteen states in the United States had laws or regulations regulating amusement rides. This Board has reviewed the laws of California, New York and Maryland.

In Canada, this Board has reviewed the laws and regulations of six provinces dealing with amusement ride safety. There is a considerable degree of similarity between the laws of various jurisdictions which have the common purpose of contributing to public safety.

The legislative methods used usually include some or all of the following:

(i) The establishment of standards applicable to amusement rides and to the owners and operators of such rides; and

(ii) The appointment of inspectors to determine whether rides and their owners and operators meet the required standards; and

(iii) Suspension or prohibition of operation unless the owner or operator has a current certificate of inspection and is not deficient in meeting the required standards; and

(iv) A requirement that the owner and operator be covered by public liability insurance or produce other evidence of financial responsibility to ensure payment of claims.

ALBERTA LEGISLATION & REGULATIONS

The applicable legislation in Alberta is the Elevator and Fixed Conveyances Act, being Chapter E-7, Revised Statutes of Alberta 1980. Pursuant to Section 2 of that Act, the Lieutenant Governor in Council has designated amusement rides as fixed conveyances to which the Act is applicable.

Pursuant to Section 21 of the Act, Order in Council 1743 of 1974 adopted Canadian Standards Association Standard Z267-1971 Midway Safety Code. This Safety Code for amusement rides was the first edition published in 1971 by the Canadian Standards Association. The Association published a second edition, intended to supercede the first, entitled Z267-M1983 Safety Code for Amusement Rides. This second edition contains many new requirements, as well as expanding considerably on items mentioned in the first edition. The purpose of this Standard is to set out safety requirements for amusement rides and to guard against personal injuries on amusement rides and at amusement parks.

In Alberta, the Order in Council adopting the 1971 Standard has not been repealed or amended and no Order in Council has been passed to adopt the 1983 Standard. The inspectors of the Elevator and Fixed Conveyances Branch state that they are applying the 1983 Standard, but no statute or regulation has been enacted empowering them to do so or requiring owners to meet that Standard.

Section 2 of the Elevator and Fixed Conveyances Act specifically provides that the Act applies to passenger elevators, freight elevators, dumb waiters, escalators, inclined passenger lifts, belt lifts, aerial tramways, chair lifts, ski tows, rope tows, mechanized parking garages, speed walks, and speed ramps. The Lieutenant Governor in Council may designate any other fixed conveyance as a fixed conveyance to which the Act applies. The Alberta Government has passed several Orders in Council adopting regulations applicable to different catagories of fixed conveyances. The only regulation it has passed dealing specifically with amusement rides is the regulation adopting the Midway Safety Code.

ADMINISTRATION

In the Board's opinion, the Elevator and Fixed Conveyances Branch of the Department of Labor is an appropriate Branch of Government to have the responsibility of inspecting and regulating amusement rides. A higher standard of care is required in respect of conveyances which carry people than is required for conveyances which only transport materials. Amusement rides carry people and in this respect they are similar to elevators, escalators, ski lifts, aerial tramways and other devices inspected by the Branch and used by the public, where precautions are required for the safety of the public using the conveyance.

STANDARDS APPLICABLE TO AMUSEMENT RIDES

The owner of an amusement ride should bear the primary responsibility for the safety of his ride. Sections of the Act should be enacted to establish the desired standard. The following excerpts from laws of other jurisdictions illustrate the application of such standards.

Saskatchewan enacted the Amusement Ride Safety Act being Chapter A-18.2 of the Statutes of Saskatchewan, 1986. Sections 7 to 9 of that Act deal with duties as follows:

"7. Every manager of an amusement ride shall:

(a) ensure that the amusement ride is used, located, designed, constructed, erected, installed, dismantled, operated, maintained, altered, repaired and tested safely and in compliance with this Act and the regulations;

(b) take every precaution reasonable in the circumstances for the protection of passengers and other persons in the vicinity of the amusement ride;

(c) ensure that every operator and any other person employed to do any work in relation to the amusement ride is adequately instructed in the proper performance of his duties;

(d) employ as operator only a person over that age and possessing those qualifications that may be prescribed in the regulations;

(e) comply with any notice, order, decision, requirement or direction of an inspector made pursuant to this Act or the regulations, within any time that the inspector may prescribe; and

(f) pay all fees and charges that are required to be paid by this Act and the regulations.

8. Every operator of an amusement ride shall:

(a) ensure that the amusement ride is operated safely and in compliance with this Act and the regulations;

(b) take every precaution reasonable in the circumstances for the protection of passengers and other persons in the vicinity of the amusement ride; and

(c) comply with any notice, order, decision, requirement or direction of an inspector made pursuant to this Act or the regulations respecting the operation of the amusement ride, within any time that the inspector may prescribe.

9.(1) Every passenger of an amusement ride shall:

(a) comply with all reasonable directions of the operators;

(b) use every safety device provided; and

(c) refrain from doing anything that might endanger the safety of another passenger or a person in the vicinity of the amusement ride.

(2) Every person in, on or about an amusement ride shall comply with any standards of conduct prescribed in the regulations."

In New Brunswick, the Elevators and Lifts Act is applicable to amusement rides, and regulations were enacted in July of 1984 reading in part as follows:

"165. No owner of an amusement device shall cause or permit the device to be operated unless he ensures that:

(a) all equipment, materials and safeguards used comply with the standards prescribed by the Act and this Part;

(b) all equipment, materials and safeguards used are maintained in good conditions;

(c) the amusement device is operated by a competent person;

(d) The amusement device is maintained by a competent person;

(e) the amusement device is examined daily by a competent person; and

(f) a log book approved by an inspector is maintained.

166. The owner of an amusement device shall ensure that the amusement device:

(a) is properly assembled;

(b) is not defective; and

(c) is safe in all parts, components, controls and safety equipment

> notwithstanding that a Certificate of Inspection has been issued respecting the amusement device."

Nova Scotia enacted the Amusement Devices Safety Act by Chapter 29 of the Statutes of Nova Scotia, 1975. The purpose of the Act is set out in Section 2 which reads as follows:

> "2. The purpose of this Act is:
>
> (a) to guard against personal injuries in the assembly, disassembly and use of amusement devices and temporary structures at carnivals, fairs and amusement parks;
>
> (b) to ensure that such amusement devices and structures shall be designed, constructed, assembled or disassembled, maintained and operated to prevent such injuries; and
>
> (c) to establish criteria for entitlement to a license to operate amusement devices and structures including the provision of insurance for persons injured or killed while in, on or about such amusement devices and structures."

Nova Scotia enacted regulations under that Act which provide:

> "3. Every owner shall ensure that:
>
> (a) all equipment, materials and safeguards required under the Act or Regulations are maintained in good condition;
>
> (b) any amusement device is operated by a competent person;
>
> (c) any amusement device is maintained by a competent person;
>
> (d) any amusement device is inspected daily by a competent person;
>
> (e) a copy of the Act and Regulations is available and maintained in good condition;
>
> in his amusement park.

4. No person shall conduct himself in, on, or about an amusement device or structure in such a manner as to:

   (a) impair the safe operation of the amusement device or structure; or

   (b) endanger the safety of himself or any other person;

   in, on or about the amusement device or structure.

5. No person shall knowingly use or suffer or permit to be used, an amusement device which is not properly assembled or which is defective or unsafe in any parts, components, controls or safety equipment; notwithstanding the fact that such amusement device has been licensed under the Act."

Article 89 of the Annotated Code of Maryland provides for Amusement Park Safety and Section 67 of that Article reads as follows:

"67. Legislative findings; purpose of subtitle:

(a) The General Assembly of Maryland finds that unsafe and defective amusement rides and attractions impose a substantial probability of serious injury upon the public exposed to the unsafe conditions and that prevention of these injuries and protection of the public from exposure to the unsafe conditions is in the best interest and welfare of the people of the State.

(b) It is the intent and purpose of this subtitle to ensure as far as possible the safety of the public in their use of rides and attractions permanently or temporarily erected at amusement parks, carnivals or fairs operated in the State by:

   (1) Providing an effective enforcement and compliance program;

   (2) Providing for the development and promulgation of safety standards and regulations;

   (3) By providing for appropriate reporting procedures with respect to the amusement ride safety to help achieve the objective of this subtitle and accurately describe the nature of carnival-amusement rides hazards."

The Board recommends that the Elevator and Fixed Conveyances Act be amended by the addition of Sections defining duties and responsibilities of owners and operators similar to the standards required in other Provinces. It appears preferable that this should be done by an amendment to the Legislation, which reflects the will of the Legislature, rather than by regulation. The standard to be established generally is that the owner is responsible for the safety of his ride

Secondly, the Board recommends that Section 2(1) of the Act be amended to refer specifically to amusement rides. At present, the Act is made applicable to amusement rides by means of an Order in Council. If the Act is applicable to amusement rides, it is clearly preferable to say so in Section 2, and the appropriate time to do so is when other Sections are being added applicable to amusement rides.

Thirdly, the Board recommends that an Order in Council be passed to adopt Canadian Standards Association Standard Z267-M1983 Safety Code for Amusement Rides so that it will legally supercede the 1971 Standard previously adopted in Alberta. This will then become a Code which owners are required to follow, and which inspectors of the Branch can enforce.

GOVERNMENT INSPECTIONS

The Elevator and Fixed Conveyances Act presently has provisions dealing with the appointment of inspectors and conferring on them duties and powers. In the opinion of the Board, these provisions appear to be adequate and no changes appear necessary or desirable.

In the opinion of the Board, it is neither possible nor desirable to staff the Branch with persons whose expertise and judgement might be substituted for the judgement and specialized skills of the designers, engineers, and manufacturers who conceive and create amusement rides.

The ultimate responsibility for the safety of such rides should continue to rest on the designers, engineers, and manufacturers who create them, and on the owners who operate them.

In the interests of the public who use such rides, the role of the Government and the inspectors it appoints is to define the standards of safety which the public should expect, and to inspect to enforce such standards.

The Government inspectors now conduct and should continue to conduct safety inspections. However, this Branch should neither be a licensing branch nor an approvals branch. The Branch conducts safety inspections of amusement rides which are operated at the owner's risk.

The Board recommends that the definition of this role be made more clear by appropriate changes in wording in the legislation and the regulations.

The Board recommends that the Branch should only issue a Certificate of Inspection and should not issue any document implying licensing or approval or using similar wording.

An owner should be prohibited from operating an amusement ride unless he holds a current Certificate of Inspection in respect of that ride. The Branch should have the express power to suspend or revoke Certificates of Inspection. Some other jurisdictions have adopted such terminology and procedures.

For instance, the New Brunswick regulations contain the following provisions:

> "166. The owner of an amusement device shall ensure that the amusement device:
>
> (a) is properly assembled;
>
> (b) is not defective; and
>
> (c) is safe in all parts, components, controls and safety equipment,
>
> notwithstanding that a Certificate of Inspection has been issued respecting the amusement device.
>
> 167 (1) Where
>
> (a) an amusement device is taken out of operation due to a broken weld, structural or mechanical failure, or
>
> (b) an accident occurs in connection with the operation of an amusement device that causes injury to any person,
>
> the owner of the amusement device shall give notice with full particulars to the Chief Inspector within twenty-four hours of the occurrence.
>
> (2) No owner shall use or cause or permit the device referred to in subsection (1) to be used until the device is inspected.
>
> 168 The Chief Inspector may suspend or revoke a Certificate of Inspection issued under this Part if he is satisfied on reasonable grounds that there is evidence of:
>
> (a) a violation of the Act or this Part, or
>
> (b) failure to comply with the direction of an inspector."

It is clear from Section 166 that the owner is responsible for safety notwithstanding that a Certificate of Inspection has been issued.

There are some provinces which make provision for licensing in the same Act that makes provision for safety inspections. This Board considers the various responsibilities may be clearer if this is not done, and licensing is effected under some other Act, such as the Licensing of Trades and Businesses Act.

In the opinion of the Board, Government inspection can and does make a significant and worthwhile contribution to the safety of the public using amusement rides. However, such inspection cannot be a guarantee of the safety of such rides.

The safety of amusement rides is dependent on a complex set of factors including design, manufacture, testing procedures, preventative maintenance, and safety inspections. The owner and his maintenance staff have responsibilities on a daily basis which can directly affect the safety of the ride. Government inspections on an annual or other periodic basis can only make an incremental contribution to safety.

FEES FOR INSPECTION

Fees for safety inspections vary considerably in different jurisdictions.

In California, the Government is authorized to collect fees for the amusement ride inspection program to make the program self-supporting.

The California regulations provide for an amusement ride inspection fee of $73.00 per hour or a fraction thereof, which is charged for all inspections, reinspections, and accident investigations pertaining to amusement rides. These are charged for actual inspection times. This begins from the time the Division Engineer arrives, generally by appointment, and continues until the engineer has completed the Division's report and is ready to leave the area.

Nova Scotia charges a nominal fee for the first inspection and an additional nominal fee for each additional inspection.

Section 37 of the Saskatchewan Act empowers the Lieutenant Governor in Council to make regulations:

> "...(n) prescribing the fees to be paid for the granting of licenses and the reinstatement of licenses that have been suspended.
>
> (o) prescribing fees and charges to be paid for inspections and reinspections, for the examination and registration of designs, plans and specifications, for testing and other services furnished and the furnishing of copies of inspection reports to persons other than managers."

In New Brunswick, the regulations provide that the fee for registration of an amusement device is $30. If an amusement device is taken out of operation due to breakage or mechanical failure or an injury accident occurs, the device cannot be used until it is inspected under Regulation 167 and the fee for such inspection under Regulation 167 is $30 per hour or any part thereof.

In Manitoba, under Section 35 of the Amusements Act, inspection fees are fixed by regulation. The fee fixed for the first inspection of a ride ranges between $10 and $20, the first additional inspection is $50 and each subsequent inspection is $100.

These comments relating to fees are for information only, and the Board makes no recommendation.

LIABILITY INSURANCE

Some jurisdictions require operators of amusement rides to produce evidence of financial responsibility to pay damage claims.

In California, under the Amusement Rides Safety Law, Section 7912 provides as follows:

> "7912 Insurance Policy, Bond or Cash Required (1968, ch. 1113)
>
> No person shall operate an amusement ride unless at the time there is in existence:
>
> (a) a policy of insurance in an amount of not less than $50,000 insuring the owner or operator against liability for injury suffered by persons riding the amusement ride, or
>
> (b) a bond in a like amount (provided however, that the aggregate liability of the surety under such bond shall not exceed the face amount thereof) or
>
> (c) cash or other security acceptable to the division."

In the State of Maryland, Section 78 reads as follows:

> "78. Insurance
>
> (a) A person may not operate an amusement ride or attraction unless he purchases insurance in an amount of not less than $300,000 against liability for injury to persons arising out of the use of the amusement ride or attraction."

In Nova Scotia, under the Amusement Devices Act, Section 20(k) empowers the Governor in Council to make regulations:

> "determining the form, amount and type of financial reponsibility necessary to satisfy claims for damages on account of any physical injury or property damage that might be suffered by any person by reason of the operation of an amusement park, amusement device or structure."

In Saskatchewan, the Amusement Ride Safety Act provides in Section 37 that the Lieutenant Governor in Council may make regulations:

> "(1) prescribing the amount, character and form of liability insurance coverage to be held by applicants for licenses and licensees;"

The Board recommends that consideration be given to amending Section 21 of the Elevator and Fixed Conveyances Act by adding a clause expressly permitting the making of regulations prescribing the form, amount and type of financial responsibility necessary to satisfy claims for damages on account of any physical injury or property damage that might be suffered by any person by reason of the operation of an amusement ride.

CERTIFICATION OF PLANS

The Elevator and Fixed Conveyances Branch performs the useful function of requiring plans of an amusement ride to be filed before the ride is permitted to operate. Unfortunately, in the case before this Board, the plans as filed differed in important respects from the trains as manufactured and delivered.

To rectify this problem for the future, it appears to the Board that the persons who sign and deliver plans should be certifying something to the Branch. The Board accordingly recommends that consideration be given to requiring a certificate from the person who signs the plans to the following or a similar effect:

(a) that my qualifications to prepare these plans are as follows______________________________;

(b) that I have prepared the plans identified by my signature and seal and they are in accordance with good engineering practice; and

(c) that the product, if it is built in accordance with these plans, will be satisfactory for the purposes for which it was designed; and

(d) to the best of my knowledge, information and belief, these are the plans which were delivered to the manufacturer of the product.

Consideration should also be given to requiring a somewhat similar certificate from the manufacturer which would certify that the product as manufactured and delivered conforms to the plans as signed, sealed and filed with the Branch.

APPENDIX A
ORDER IN COUNCIL

"W. HELEN HUNLEY"
LIEUTENANT GOVERNOR

"THE SEAL OF THE
PROVINCE OF ALBERTA"

ELIZABETH THE SECOND, by the Grace
of God, of the United Kingdom,
Canada, and Her Other Realms and
Territories, QUEEN, Head of the
Commonwealth, Defender of the Faith

COMMISSION

To all to Whom these Presents shall come,
or Whom the same may in anywise concern,

GREETING....

CANADA
PROVINCE OF ALBERTA

WHEREAS it is expedient and in the public interest to cause an inquiry to be made into and concerning the matters hereinafter set out; and

WHEREAS We declare that the matters hereinafter set out are matters of public concern:

NOW KNOW YE that by and with the advice and consent of Our Lieutenant Governor in Council, we do by these Presents appoint, pursuant to the Public Inquiries Act, as Commissioners, a Board of Inquiry consisting of Mr. Kenneth A. McKenzie, Q.C., of Edmonton as Chairman and Dr. Geoffrey L. Kulak of Edmonton to inquire into and report on the accident involving the roller-coaster (recorded with the Department of Labour as "A840052 - Triple Loop Coaster") at West Edmonton Mall, in the City of Edmonton in the Province of Alberta on June 14, 1986 and in particular to inquire into and report on:

1. the design, construction, installation, maintenance and operation of the roller-coaster;

2. the factors contributing to, causes of and circumstances connected with the accident;

3. the adequacy of existing provincial laws, regulations, rules and standards governing amusement ride operations and safety, insofar as they relate to the accident;

4. the adequacy of existing practices, procedures and standards governing amusement ride operations and safety followed by the owners and operators of the roller-coaster, insofar as they relate to the accident;

5. the performance of all persons and mechanical components involved in the operation of the roller-coaster;

6. the steps that can reasonably be taken to reduce the risk of recurrence of such accidents; and

7. any matters incidental or relating to any of the matters referred to in paragraphs 1 to 6.

IN TESTIMONY WHEREOF We have caused these Our Letters to be made Patent and the Great Seal of Our Province of Alberta to be hereunto affixed.

WITNESS: THE HONOURABLE W. HELEN HUNLEY, Lieutenant Governor of Our Province of Alberta, in Our City of Edmonton in Our Province of Alberta, this 20 day of June in the Year of Our Lord One Thousand Nine Hundred and Eighty-six and in the Thirty-fifth Year of Our Reign.

BY COMMAND

D.A.G. Provincial Secretary

ALBERTA
ORDER IN COUNCIL

APPROVED AND ORDERED	O.C. 410/86
"W. HELEN HUNLEY"	June 20, 1986
LIEUTENANT GOVERNOR	EDMONTON, ALBERTA

Whereas it is expedient and in the public interest to cause an inquiry to be made into and concerning the matters hereinafter set out; and

Whereas the matters hereinafter set out are matters of public concern:

Therefore, upon the recommendation of the Honourable the Minister of Labour, the Lieutenant Governor in Council, pursuant to the Public Inquiries Act, appoints as commissioners, a Board of Inquiry consisting of Mr. Kenneth A. McKenzie, Q.C., of Edmonton as Chairman and Dr. Geoffrey L. Kulak of Edmonton to inquire into and report on the accident involving the roller-coaster (recorded with the Department of Labour as "A840052 - Triple Loop Coaster") at West Edmonton Mall, in the City of Edmonton in the Province of Alberta on June 14, 1986 and in particular to inquire into and report on:

1. the design, construction, installation, maintenance and operation of the roller-coaster;

2. the factors contributing to, causes of and circumstances connected with the accident;

3. the adequacy of existing provincial laws, regulations, rules and standards governing amusement ride operations and safety, insofar as they relate to the accident;

4. the adequacy of existing practices, procedures and standards governing amusement ride operations and safety followed by the owners and operators of the roller-coaster, insofar as they relate to the accident;

5. the performance of all persons and mechanical components involved in the operation of the roller-coaster;

6. the steps that can reasonably be taken to reduce the risk of recurrence of such accidents; and

7. any matters incidental or relating to any of the matters referred to in paragraphs 1 to 6.

"Don R. Getty"

CHAIRMAN

APPENDIX B
PROCEDURAL MATTERS

Three people were killed, and a fourth seriously injured, when they were thrown from a train on the triple loop roller coaster at West Edmonton Mall in Edmonton, Alberta on the evening of June 14, 1986. On June 20, the Lieutenant Governor in Council for Alberta, pursuant to the Public Inquiries Act of Alberta, appointed a Board of Inquiry consisting of Mr. Kenneth A. McKenzie, Q.C., as Chairman and Dr. Geoffrey L. Kulak, P. Eng., to inquire into and report on the accident. The Board's terms of reference are set out in Order in Council No. 410/86 (Ex. 1).

The members of the Board decided that Public Hearings would be held, at which witnesses would be asked to give evidence under oath relevant to the subjects mentioned in the terms of reference. Pursuant to Preliminary Guidelines that the Board distributed to counsel and made available during the Hearings, the Board identified "major participants" in the Inquiry; they were invited to participate in the proceedings. Those who were represented at the Hearings were:

(a) West Edmonton Mall Ltd., Triple Five Corporation Ltd. and B.K. Maintenance Ltd. ("Triple Five");

(b) Elevators and Fixed Conveyances Branch, Department of Labour, Government of Alberta;

(c) Werner Stengel, the engineer whose firm prepared the static calculations for the roller coaster.

Schwarzkopf GmbH, the manufacturer, was also identified as a "major participant", but was not represented at the Hearings.

During the first stage of the Public Hearings, which took place between July 21 and November 26, 1986, Commission

Counsel called witnesses and examined them on behalf of the Board. This included both lay and expert witnesses. Counsel for the major participants were permitted to cross-examine. One expert witness gave evidence at that time on behalf of Triple Five and was cross-examined by Commission Counsel and counsel for the other major participants. After Commission Counsel had presented the evidence obtained on behalf of the Board, counsel for the major participants were invited to call witnesses or present evidence on behalf of their respective clients. Two witnesses were then called on behalf of Triple Five.

During the second stage of the Public Hearings, which took place between April 13 and 16, 1987, a number of witnesses were called on behalf of Triple Five. Commission Counsel and counsel for the other major participants were permitted to cross-examine these witnesses.

The evidence presented to the Board at the Public Hearings was organized into a number of categories. As much as possible, the categories were heard in order and each was completed before the next began. The categories were identified as follows:

(a) Acquisition;
(b) Approval Process;
(c) Construction;
(d) Commissioning;
(e) Operations;
(f) Maintenance;
(g) The Accident - June 14, 1986;
(h) Investigation and Findings;
(i) Expert Evidence

Exhibits presented at the Public Hearings were entered into the record and identified by the Board's Registrar. By agreement amongst counsel, exhibits which became available after the first adjournment of the Public Hearings were entered into the record without convening the proceedings. A transcript was kept of all oral evidence. Members of the public and the media were invited and did attend at the Hearings, and the media was permitted to have one still and one television camera at the proceedings. In addition to the Public Hearings, the members of the Board attended at West Edmonton Mall on several occasions to view the roller coaster and the surrounding area. A professional engineer, Dr. C. James Montgomery, was retained by the Board to advise on suitable tests for physical evidence and to provide opinions on technical matters.

Advertisements were published informing the public of the terms of reference of the Inquiry and inviting written submissions to the Board. A number of responses were received and reviewed and counsel for the major participants were invited to view the submissions.

MANDATE

The Order in Council appointing this Board of Inquiry directs the Board "to inquire into and report on the accident involving the roller-coaster... and in particular to inquire into and report on..." certain enumerated items. The Board understands its mandate to be to review all of the evidence it has obtained, determine the facts relevant to the terms of reference, and report on those facts to the Minister of Labour. The breadth of the terms of reference has necessarily required the Board to analyze both the causes of the accident as well as other issues on which it was instructed to report. However it is not the Board's responsibility to suggest any specific design changes for the roller coaster or to determine what steps must be taken before the ride is reopened to the public.

APPENDIX C

STATISTICS

Date of Accident:	June 14, 1986
Date of Appointment of Board of Inquiry:	June 20, 1986
Commencement of Public Hearings:	July 21, 1986
First Adjournment of Public Hearings:	November 26, 1986
Re-commencement of Public Hearings:	April 13, 1987
Second Adjournment of Public Hearings:	April 16, 1987
Total Number of Sitting Days:	58
Total Number of Witnesses:	85
Total Number of Pages of Transcript:	6155
Total Number of Exhibits:	306

APPENDIX D

COUNSEL LIST

1. Commission Counsel

	FIRM
Bryan J. Kickham, Commission Counsel Margaret E. Coates, Associate Counsel	Bishop & McKenzie Barristers & Solicitors

2. Major Participants

SOLICITOR	FIRM	COUNSEL FOR
Jack N. Agrios, Q.C. Robert Duke William S. Sowa and Susanne Palmer	Jack N. Agrios, Q.C. Cormie Kennedy Brownlee Fryett	Triple Five Corporation Ltd., West Edmonton Mall Ltd. and B.K. Maintenance Ltd.
Arthur P. Hnatiuk, Q.C.	Alberta Attorney General Civil Law	Elevators & Fixed Conveyances Branch, Department of Labour
L.W. Drewry, Q.C.	Emery Jamieson	Werner Stengel Engineering Office

3. Participants and Witnesses

SOLICITOR	FIRM	COUNSEL FOR
S.D. Laird, David Cook and A. Bassett	Duncan, Craig, Cooke Shandling	Rodney Chayko
S.F. Goddard and Brian Heck	Parlee McLaws	PCL Construction Management Inc.
C.P. Russell	Cruickshank Phillips	Northern Steel Industries Ltd.
James Peacock	Code Hunter	Ball Welding & Metallurgical Engineering Ltd.
Alan R. Gray	Lucas, Bishop & Fraser	Canron Inc.
D.A. McGillivray	Macleod Dixon	Calaway Park
D. R. Pahl	Cleall, Pahl	Estates of Anthony Mandrusiak and Cindy Sims

APPENDIX E

WITNESS LIST

ABELE, Anton
ANDERSON, Clifford J.

BAKER, Raymond Nelson
BALL, Bruce E.
BEESLEY, John
BLACKWATER, Pamela
BREED, Arthur Raymond
BROWER-BERKHOVEN, Isaac
BROWN, Brian

CANNER, William
CARIOU, Shawn
CARR, Clint Allan
CHAYKO, Rodney Louis
CODERRE, Luc
COLLINS, Rob
CORBETT, Tammy
CORSBIE, Marion
CUNNINGHAM, Garry James
CURTIS, Myra

DESILETS, Chris
DILLON, Garfield Frank
DOUCETTE, Emile

FESER, Darren Leight
FLETCHER, John
FONTAINE, David Paul
FOWLER, Des

GHERMEZIAN, Eskandar
GLEN, Kenneth Allan
GRIEVE, Ross
GRIFFIN, Allan Nelson
GUTHRO, Kenneth

HALISKY, Shelly
HAMRE, Edmond Charles
HINDE, John Phillip
HOLDSWORTH, Douglas Bryce
HOOGENSEN, Christian Peter
HORNE, Kelvin Arnold
HOUSTON, Stuart Frederick

JACOBSON, Garry Oliver
JORDAN, Dean Michael

KAPTY, Cameron Scott
KAREN, Rodney Joseph
KEUR, William C.
KLARL, Konrad
KOBI, Tracy Lynn
KOWALKOWSKI, John Stanislaw

LEIGHT, Eugene
LIEBE, Krista
LEUTENSTORFER, Peter

MACKIE, Mary
MALBEUF, Howard Harry
MALESZEWSKI, Lester
McGOWAN, Gary
McINTYRE, Shawn Joseph
McLACHLAN, Larry J.
MILLWARD, Henry Stephen
MINKE, Wayne John
MONTGOMERY, Colin James
MOONEY, Michael James
MROCHUK, Alan

OMILIAN, Cheryl

PARKIN, Norman
PENN, David Leslie
PIPKE, David Dwayne
POTVIN, Elliott James

ROSS, Jennifer
RUSSELL, Lisa

SALACKI, Joseph
SCHEER, Wayne David Sr.
SCHLINGMANN, Herbert Gerard
SCOTT, Phillip
SHEPEL, Leanne
SMITH, David Gordon
SMITH, Randall Courtney
STEEN, Glenn
STENGEL, Werner Bernhard
STORFIELD, Wayne
STRULICK, Michael
SWEET, Michael

TURTLE, Gordon Bruce

UPTON, Matthew Petticrew

VAN DEN BRANDE, John
VAN KERSTEREN, Robert Allen
VIEBAHN, Wolfgang

WAYMAN, Michael

YUCKER, Willie

ZYLSTRA, Albert

APPENDIX F

LIST OF EXHIBITS

1. Order in Council dated June 20, 1986
2. Notice placed in Edmonton Journal - June 30, 1986
3. Notice placed in Edmonton Journal - July 16, 1986
4. Contract dated November 29, 1984 between Triple Five Corporation Ltd. and Schwarzkopf GmbH - Purchase of Roller Coaster
5. Inter office memorandum dated November 20, 1985 from Eskandar Ghermezian to Staff - Re; Safety
6. Letter dated November 25, 1985 from PCL Construction Management Inc. to West Edmonton Mall Ltd. - Re; inspection during fabrication
7. Letter dated September 20, 1985 from Triple Five Corporation Ltd. to Abugov & Associates - Re; inspection of rides
8. Technical documentation and drawings (German) - Mechanical, Electrical and Structural
9. Technical documentation and drawings (English) - Mechanical, Electrical and Structural
10. Erection report dated December 20, 1985 from the Trustee, Schwarzkopf GmbH to Triple Five Corporation Ltd.
11. Agreement dated July 2, 1985 - beteween Triple Five Corporation Ltd. and The Trustee, Schwarzkopf GmbH - Re; Track Portion
12. Agreement dated July 12, 1985 between Triple Five Corporation Ltd. and the Trustee, Schwarzkopf GmbH - Re; Completion of Ride
13. Agreement dated July 12, 1985 between Trustee, Schwarzkopf GmbH and Triple Five Corporation Ltd. - Re; Arrangements with Creditors
14. Agreement dated November 12, 1985 between Trsutee, Schwarzkopf GmbH and Triple Five Corporation Ltd. - Re; Final Accounting
15. Supplementary Agreement dated November 14, 1985 between Trustee, Schwarzkopf GmbH and Triple Five Corporation Ltd. - Re; Spare Parts

16. Spare parts list recommended inventory dated August 15, 1985 by United States Schwarzkopf Company

17. Telefax dated November 19, 1985 to Michael Mooney from the Trustee, Schwarzkopf GmbH

18. Brochure of triple loop roller coaster

19. Catalogue of the rides manufactured by Schwarzkopf

20. Inspection Report dated March 13, 1986 from Werner Stengel to PCL Construction Ltd.

21. Elevator and Fixed Conveyance Act, Chapter E-7, R.S.A. 1980

22. Elevators and Fixed Conveyances Regulations published November 15, 1974

23. C.S.A. Standard Z267-1971 Midway Safety Code

24. C.S.A. Standard Z267-1983 Safety Code for Amusement Rides

25. Elevator and Fixed Conveyance Inspection Procedures

26. Plan 1

27. Plan 2

28. Plan 4A

29. Plan 4B

30. Plan 4C

31. Plan 4D

32. Plan 5

33. Plan 6

34. Plan 7

35. Plan 8

36. Plan 9

37. Sheet 2

38. Letter dated January 3, 1985 from Alberta Labour to Moorehead Fleming & Co.

39. Plan 3

40. Letter dated August 29, 1985 from Alberta Labour to Moorehead, Fleming, & Co.

41. Alberta Labour record of documents received - Re; Rides for Fantasyland Phase II

42. Technical Report by Ball Welding & Metallurgical Engineering Ltd. dated March 14, 1986

43. Letter dated December 20, 1985 from PCL Construction Management Inc. to Alberta Labour

44. Electrical drawings - roller coaster

45. Letter dated December 9, 1985 from Alberta Labour to PCL Construction Management Inc.

46. Electrical Protection Branch Inspection Reports dated December 10, 1985 and December 20, 1985

47. Letter dated January 2, 1986 from Alberta Labour to PCL Construction Management Inc. - Re; initial inspection of December 10, 1985

48. Letter dated January 14, 1986 from Alberta Labour to Triple Five Corporation Ltd. - Re; engineering calculations - English Maintenance Manual

49. Memo dated January 27, 1986 from PCL Construction Management Inc. to Alberta Labour - Re; drawings for coaster

50. Three page document (German) - DIN Specifications

51. One page document (German) - list of technical documentation

52. Letter dated February 14, 1986 from Alberta Labour to PCL Construction Management Inc. - Re; operations and maintenance documents in English

53. Letter dated February 21, 1986 from Alberta Labour to Triple Five Corporation Ltd. - Re; receipt of engineers endorsed drawings

54. Letter dated January 22, 1986 from Werner Stengel to Triple Five Corporation Ltd. - Re; calculations and drawings

55. Letter dated December 24, 1985 from Abugov & Associates to Alberta Labour - Re; Coaster foundations

56. Memorandum - Triple Loop Roller Coaster Emergency Walk Down Procedure

57. Construction Management Agreement dated August 23, 1984 between West Edmonton Mall Ltd. and PCL Construction Management Inc. - Stage III

58. Translation of Coaster Maintenance Manual

59. Telefax dated October 14, 1985 from Schwarzkopf GmbH to PCL Construction Management Inc. - Re; removal of trains from containers

60. Minutes of roller coaster meeting held on November 15, 1985

61. Agreement dated May 1, 1985 between West Edmonton Mall Ltd. and Northern Steel Inc.

62. West Edmonton Mall Stage III Common Documents - Construction and Rides

63. Telexes and letter between PCL Construction Management Inc., Northern Steel Inc. and Canron Inc. dated July 30, 1985, September 18, 1985, November 15, 1985 and March 14, 1986 - Re; erection of coaster track

64. Proposal dated May 9, 1985 from Ball Welding & Metallurgical Engineering Ltd. to PCL Project Management Inc. Re; inspection of structural steel

65. Ball Welding & Metallurgical Engineering Ltd. Technical Reports - June 20, 1985 to November 7, 1986

66. Bundle of inspection reports from Ball Welding & Metallurgical Engineering Ltd. to PCL Construction Management Ltd. - September 4, 1985 to May 12, 1986

67. Telex dated December 13, 1985 from PCL Construction Management Inc. to Wolfgang Viebahn

68. Letter dated April 24, 1985 from Canron Inc. to Northern Steel Inc. - Re; Tender

69. Telex dated May 9, 1985 from Canron Inc. to Wolfgang Viebahn

70. Bundle of drawings - track structure

71. Telex dated August 12, 1985 from Canron Inc. to Northern Steel Inc.

72. Canron Inc. colored Construction Chart

73. Certificate of Substantial Performance dated December 11, 1985 from PCL Construction Management Inc. to West Edmonton Mall Ltd. and Abugov & Associates

74. Handwritten memo from Wolfgang Viebahn to PCL Construction Management Inc. - Re; erection of track loops

75. Memorandum dated March 14 1986 from Canron Inc. to PCL Construction Management Inc. - Re; track test results

76. Technical Reports dated August 12, 1985 and December 4, 1985 from Ball Welding & Metallurgical Engineering Ltd.

77. Letter dated March 24, 1986 from Alberta Labour to Canem Systems Ltd. - Re; electrical approvals

78. Telefax dated December 13, 1985 from Wolfgang Viebahn to Triple Five Corporation Ltd. and PCL Construction Management Inc. - Re; engineering approvals on drawings

79. Triple loop roller coaster model

80. Diagram - train position indicator panel - main control

81. Diagram - unload station panel

82. Roller coaster log sheets - April 3, 1986 to June 14, 1986

83. Employment History - Shaun Cariou and Robert Manolson

84. Roller Coaster Operators list

85. Roller Coaster Attendant list - March 15, 1986

86. Roller Coaster Attendant Manual May, 1986

87. Roller Coaster Operator Manual May, 1986

88. Roller Coaster Operations Manual - December 20 to January 5, 1986

89. Cast Handbook - Fantasyland Parks & Attractions

90. Original copy of technical documentation and drawings (Exhibit 8)

91. Roller Coaster Maintenance Log - March 29, 1986 to June 14, 1986

92. Roller Coaster Daily Maintenance Sheet - June 9, 1986 to June 12, 1986

93. "To do list" for roller coaster - April 20, 1986 to June 12, 1986

94. Ride Start-up and Fault Log

95. Daily Time Sheets - Mechanics and Electricians - March, 1986 to April 30, 1986

96. Daily Time Sheets - Mechanics and Electricians - May 1, 1986 to June 9, 1986

97. Daily Time Sheets - Mechanics and Electricians - 8 June, 1986 to 14 June, 1986

97A. Daily Time Sheets

98. Memorandum - Houston to Keur dated April 16, 1986 - Testing Summary II - Track

99. Memorandum - Houston to Keur dated May 21, 1986 - Testing Summary III - Track

100. Daily Maintenance/Lubrication Schedule - Wave Swinger

101. Daily Maintenance/Lubrication Schedule - Roller Coaster

102. Daily/Weekly Maintenance/Lubrication Schedule - Free Fall

103. Letter dated March 27, 1985 from Alberta Labour to Triple Five Corporation Ltd. - Re; Maintenance

104. Document entitled "Chain of Command" of B.K. Maintenance Ltd.

105. Daily Maintenance/Lubrication Schedule - Mechanical

106. Letter dated June 13, 1986 from B.K. Maintenance Ltd. to Alberta Labour

107. Alberta Labour Incident Report Form

108. Daily Maintenance/Lubrication Schedule - Electrical

109. Letter dated April 25, 1985 from I.R.I.S. to West Edmonton Mall Ltd.

110. I.R.I.S. Inspection Report - Fantasyland rides

111. I.R.I.S. Video Inspection Report dated June 20, 1985

112. Electrical description of operation - English

113. Inter-office memorandum dated April 22, 1985 from Griffin to Millward

114. Letter dated April 12, 1985 from Schwarzkopf GmbH to Alberta Labour - Re; welds

115. Letter dated April 12, 1985 from Schwarzkopf GmbH to Alberta Labour

116. Plans prepared by Abugov & Associates - September, 1985

117. Report of a telephone conversation between Karen and Keur dated April 24, 1986

118. Report of a meeting dated May 1, 1986 between Mr. Karen and Mr. Keur

119. Note of Lester Maleszewsky - Re; roller coaster accident on April 6, 1986

120. Witness Statement dated June 15, 1986 - Upton

121. Check Lists prepared by Pipke - May 31, 1986

122. Notes made by Pipke in discussion with Schuller

123. Draft Check Lists prepared by Pipke - April 21, 1986

124. Witness Statement dated June 15, 1986 - Al Zylstra

125. Witness Statement dated June 18, 1986 - Al Zylstra

126. Book of photographs - police

127. Witness Statement dated June 27, 1986 - Potvin

128. Inter-office memo dated June 11, 1986 from Sean Cariou to area 1 operators and attendants

129. Inter-office memo dated April 11, 1986 from Ken Glenn to Sean Cariou

130. Witness Statement dated June 17, 1986 - David Smith

131. Witness Statement dated June 16, 1986 - Dean Jordan

132. Witness Statement dated June 16, 1986 - Cameron Kapty

133. Witness Statement dated June 16, 1986 - Garry Cunningham

134. Report showing location and description of exhibits taken from the accident scene

135. Report indicating measurements of exhibits from the accident scene

136. Blueprint plan of the roller coaster area

137. Accident Report dated July 10, 1986 from Karen to Millward

138. Accident Investigation memo dated July 10, 1986 from Karen to Millward

139. Handwritten notes by Griffin - torque values

140. Memorandum dated June 11, 1986 from Karen to Millward - Torque Test

141. Letter dated August 28, 1986 from Alberta Labour to Jack Agrios

142. Inspector's Report dated August 1, 1986 by Griffin - Re; test run

143. Accident Investigation Report dated July 11, 1986 by Karen

144. Inspector's Report dated June 16, 1986 by Griffin - Re; torque value test

145. Loctite Corporation Product Data Sheet

146. Bolt hole drawing by Mr. Karen - blue train

147. Telexment dated June 25, 1986 from Schwarzkopf to Triple Five Corporation Ltd.

148. Video tape of of June 16, 1986 - Werner Stengel and Schwarzkopf

149. Detective Strulick's Report

150. Handwritten notes of Detective Strulick

151. Blueprint of the roller coaster - showing locations of loose bolts

152. Letter dated September 15, 1986 from Canron Inc. to B.K. Maintenance Ltd. - Re; Houston

153. Substance of opinion dated October 3, 1986 with attached Resume - McLachlan

154. Maintenance Forms - Light Rail Transit

155. Arthur Breed Activity Summary

156. Arthur Breed - Conclusions

157. Bronze bushing marked "top" - car 4

158. Bronze bushing marked "bottom" - car 4

159. Vertical trunnion car 4, left-hand bogie

160. Bearing outer sleeve - car 4
161. Top keeper plate - car 4
162. Steel roller bearing marked "top"
163. Steel roller bearing marked "bottom"
164. Vertical trunnion - left back bogie car 1, train 1
165. Bottom keeper plate - left back bogie car 1, train 1
166. Upper keeper plate - left back bogie car 1, train 1
167. Accelerometer reading - loads on bogies
168. Broken bolt - Red Train #4 found on May 21
169. Broken bolt - Red Train #4 - found during torquing procedure
170. Diagram 103-04-01-06-01 - Vertical Trunnion
171. Diagram 103-04-1-2800 - Trunnion and Keeper Plate
172. Drawing Number 103-04-01-06-03 - Keeper Plate Assembly
173. Keeper plate to the left rear bogie
174. Keeper plate bolt
175. Keeper plate bolt
176. Keeper plate bolt
177. Keeper plate bolt
178. Calaway Park Coaster Manual
179. Corkscrew Roller Coaster Maintenance
180. Calaway Park Winter Maintenance Program
181. Testing Summary IV prepared by Houston - steel
182. Letter dated September 11, 1984 from Dennis Boutin of Canron Inc. - Re; Houston Job Reference
183. Photographs of jobs - Houston
184. Time Sheets June 6 to June 21, 1986 - steelworkers
185. Diagram No. 103-04-01-28-00 - May 22, 1985

186. Diagram No. 103-04-01-06-00 - May 1, 1985

187. Diagram No. 103-04-01-26-00 - June 18, 1985

188. Diagram No. 103-04-01-24-00- May 14, 1985

189. Diagram No. 103-04-03-00-00 - June 21, 1985

190. Diagram No. 103-04-01-19-00

191. Diagram No. 103-04-01-06-11

192. Diagram No. 103-04-01-06-10

193. Diagram No. 103-04-01-06-06

194. Diagram No. 103-04-01-06-09

195. Diagram No. 103-04-01-06-08

196. Diagram No. 103-04-01-06-07

197. Information Sheet No. 103-04-01-27-00

198. Diagram No. 103-04-01-19-01

199. PCL Construction Management Inc. correspondence with Wolfgang Viebahn

200. Triple Five Corporation Ltd. correspondence with Wolfgang Viebahn

201. Schwarzkopf site sketches of Plant No. 1 and Plant No. 2 prepared by Viebahn

202. Schwarzkopf shipping documents from October, 1985 - 6 trains

203. Abele - Record of shop drawings

204. Abele - Record of meetings with Mr. Schwarzkopf

205. Klarl - notes of March 1, 1985 meeting

206. Parts List No. 103-04-03-03-00 - Re; cast iron

207. Report of Dr. Hamre

208. Long bolt from crane

209. Short bolt from crane

210. Page 367 - photograph from book "Deformation and Fracture Mechanics of Engineering"

211. Report by Werner Stengel dated June 22, 1986

212. Report dated July 21, 1986 referring to four loop coaster in Germany

213. TUV Report dated August 27, 1986 - triple loop coaster

214. Affidavit of Michael J. Mooney dated October 15, 1986

215. Curriculum Vitae prepared by Dr. Montgomery

216. Lamb McManus & Associates Interim Inspection Reports dated June, July and August, 1986

217. Final Investigation Report prepared by Dr. Montgomery

218. Plans P-1 to P-12 - Lamb McManus & Associates

219. Model of trunnion and keeper plate

220. Translation of Stengel's D.I.N. specifications

221. Page 28 of D.I.N. 4112 book

222. Terms of Reference (German) - Stengel firm

223. Time Records - Stengel firm

224. Time records - Steinenger

225. Drawing No. 103-04-02-09-00 - connection for cars

226. Drawing No. 103-04-01-06-02 - vertical axle

227. Drawing No. 103-04-01-06-02 - top ring

228. Three pages - Drawing No. 103-04-01-06-00 - vertical axle, bearing and bushing

229. Stengel calculations - triple loop

230. Stengel calculations - vertical axle for the four loop roller coaster

231. Stengel Track Design Modifications

232. TUV Preliminary Approval - four loop roller coaster

233. Thriller Bruch - Drawing No. 12

234. Thriller Bruch - Drawing No. 13

235. Transmittal slip - Werner Stengel to Schwarzkopf GmbH - December 3, 1985

236. Letter dated April 3, 1986 from Werner Stengel to Triple Five Corporation Ltd.

237. Drawing No. 9 - Modification Plan for Vertical Axle - Stengel

238. Drawing No. 1 - Modification Plan for Vertical Axle - Stengel

239. List of parts and specifications - thicker keeper plate and ring

240. Package of documentation and drawings provided by Stengel

241. Drawing No. 103-04-01-26-00

242. Drawing No. 103-04-01-24-00

243. Letter dated December 4, 1984 from Westrick and Eckholdt to Triple Five Corporation Ltd. - Re; Breidenbach Guarantee

244. Breidenbach Guarantee executed by Triple Five December 1, 1984

245. Land Charge Agreement dated November 30, 1984 - Re; Schwarzkopf plant

246. Chattel Mortgage dated November 30, 1984 between Schwarzkopf GmbH and Triple Five Corporation Ltd.

247. Letter dated November 27, 1984 from Canadian German Chamber of Industry and Commerce to Triple Five Corporation Ltd. - Re; Breidenbach Credit Report

248. Letter dated June 26, 1985 from Schanbacher, Inhof & Co. to Triple Five Corporation Ltd.

249. Inter-office memo dated June 25, 1985 from Margaret to Eskandar - Re; Receivership and Guarantees

250. Telex dated July 3, 1985 to Triple Five Corporation Ltd. - Re; coaster funds

251. Letter dated October 15, 1985 from Westrick and Eckholdt to Inhof and letter dated October 2, 1985 from Theo Becker to Westrick and Eckholdt (translated)

252. Letter dated November 25, 1985 from District Court Neu-ulm to Triple Five Corporation Ltd. with attached list of properties (translated) - Re; Marianne Becker Receivership

253. Handwritten memo dated October 25, 1985 from Corsbie to Lang - Re; creditors

254. Handwritten memo from Corsbie to Keur - Re; Stengel drawings

255. Financial Statement as at December 12, 1985

256. Financial Statement as at January 24, 1986

257. Calculation of costs dated November 15, 1985 - Mooney

258. Inter-office memo dated February 25, 1985 from Marion Corsbie to Eskandar, Michael Mooney, Maria Lang and Bill Keur - Re; spare parts

259. Letter dated October 16, 1986 from McMillan Binch - Loctite answers and catalogue

260. Maintenance documents

261. APEGGA Submission

262. Declarations of Documents - Mooney, Keur, Grieve and Millward

263. Hanson Materials Engineering Report dated October 27, 1986

264. Hanson Materials Egineering Report dated October 28, 1986

265. Curriculum Vitae of Hoogensen

266. Failure Analysis - Hoogensen

267. Drawing of the trunnion assembly - Hoogensen

268. Graph of strain analysis - shear pin

269. Combined graph of strain analysis - pin

270. Graph of strain analysis - keeper plate bolts

271. Diagram of modifications - trunnion assembly

272. Letter dated November 12, 1986 from Lamb McManus to Board of Inquiry - Re; tests of screws

273. Letter dated November 13, 1986 from Lamb McManus to Board of Inquiry - Re; stresses on screws

274. Translations of portions of Maintenance Manual by Ms. Liebe

275. Copy of English Maintenance Manual (Exhibit 8) with handwritten notes of Ms. Liebe

276. Diagram prepared by Dr. Montgomery

277. Diagram prepared by Hoogensen

278. Letter dated November 17, 1986 from Hoogensen Metallurgical Engineering to Jack Agrios - Re; calculations

279. Report to Mr. Kickham from Dr. Wayman dated November 19, 1986

280. Letter dated October 21, 1986 from Alberta Labour to Bishop & McKenzie - Re; undertakings of the Elevators and Fixed Conveyances Branch

281. Answers to undertakings of Triple Five Corporation Ltd. and B.K. Maintenance Ltd.

282. Letter dated August 20, 1986 from Code Hunter to Bishop & McKenzie - Re; undertakings of Dr. Ball

283. Letter dated August 5, 1986 from Parlee McLaws to Bishop & McKenzie - Re; undertakings of PCL Construction Management Inc.

284. Letter dated September 2, 1986 from Cruickshank Phillips to Bishop & McKenzie - Re; undertakings of Northern Steel Inc.

285. Letter dated August 14, 1986 from Lucas, Bishop & Fraser to Bishop & McKenzie - Re; undertakings with of Canron Inc.

286. Letter dated November 4, 1986 from Werner Stengel to Emery Jamieson with attached documentation

287. Memorandum from IMA dated November 5, 1986, together with 19 documents

288. Telex dated July 10, 1986 from Peter Hee to Bishop & McKenzie - information Re; Schwarzkopf

289. Telex dated July 23, 1986 from Peter Hee to Bishop & McKenzie - information Re; Schwarzkopf

290. Letter dated August 21, 1986 from Alberta Labour to R.J. Coulter & Associates

291. Memorandum dated September 9, 1986 from R.J. Karen to H.S. Millward

292. Excerpt from Schaffler Indictment with English translation - August 22, 1985

293. Excerpt from newspaper article of October 23, 1986 with English translation - Re; conviction

294. Report from Hanson Materials dated November 26, 1986 - Re; keeper plate loctite

295. Letter from Emery Jamieson dated December 8, 1986 - Re; undertakings of Werner Stengel

296. Letter from Hoogensen Metallurgical Engineering dated December 16, 1986 - Re; answers to undertakings

297. Letter from Jack Agrios dated December 16, 1986 - Re; answers to undertakings - Mooney, Keur, Upton and Penn

298. Letter from Hoogensen Metallurgical Engineering to Jack Agrios dated December 15, 1986

299. Letter from Jack Agrios dated January 19, 1987 - Re; answers to undertakings

300. N/A

301. Measurements conducted by John Beesley

302. Certificate of Accuracy of Calibration

303. Certificate of Accuracy of Table

304. Pamphlet re; Height Setting Micrometer

305. Cirriculum Vitae of Clifford J. Anderson

306. Measured deviations plotted into graphical form

APPENDIX G

PRINCIPAL PERSONS MENTIONED IN THE REPORT

Part One

ABELE, Anton. Mechanical engineer and head of the firm of IMA, which prepared the drawings for the trains.

BACHSCHMIDT, Mr. Chief Designer at Schwarzkopf GmbH. Responsible for production of the track and supporting structure in the plant.

BALL, Dr. Bruce, P. Eng. Metallurgical engineer, certified weld inspector and the principal of Ball Welding & Metallurgical Engineering ltd.

BECKER, Theo. Part owner of Schwarzkopf GmbH.

BREIDENBACH, Herbert. Part owner of Schwarzkopf GmbH.

BROWER-BERKHOVEN, Isaac. Supervisor of mechanical department of B.K. Maintenance Ltd.

CANNER, William. General Manager of Fantasyland and head of Operations. Employed by Triple Five Corporation Ltd.

CARIOU, Shaun. Training co-ordinator and area supervisor responsible for the roller coaster among other rides.

CARMELE, Dr. Wolfgang. Business Manager of Schwarzkopf GmbH.

CORSBIE, Marion. Executive Director, Marketing, Triple Five Corporation Ltd.

CUNNINGHAM, Garry. Unloading attendant at the roller coaster at the time of the accident. Employed by Triple Five Corporation Ltd.

FLETCHER, John. Project adminstrator with Canron Inc.

GHERMEZIAN, Eskandar. President of Triple Five Corporation Ltd.

GLENN, Ken. Operations Manager for Fantasyland.

GRIFFIN, Allan. Inspector with the Elevators and Fixed Conveyances Branch of the Department of Labour. Responsible for the territory which includes Fantasyland.

HANSEN, Doug. Worked as an attendant on the roller coaster during the Christmas period. Employed by Triple Five Corporation Ltd.

HOUSTON, Stuart. Head of steelworkers department of B.K. Maintenance Ltd.

JORDAN, Dean. Loading attendant at the roller coaster at the time of the accident. Employed by Triple Five Corporation Ltd.

KAPTY, Cameron. Ticket attendant at the roller coaster at the time of the accident. Employed by Triple Five Corporation Ltd.

KAREN, Rodney. Senior inspector with the Edmonton office of the Elevators and Fixed Conveyances Branch of the Department of Labour.

KEUR, William. Mechanical Director of Triple Five Corporation Ltd. and President of B.K. Maintenance Ltd., the maintenance division of Triple Five Corporation Ltd. In charge of maintenance for all of Triple Five's properties in Edmonton.

KLARL, Konrad. Mechanical engineer employed by the firm of IMA. Usual contact on behalf of IMA with Anton Schwarzkopf and the Stengel firm. Prepared the shop drawings of the roller coaster trains.

KLEIN, Mr. Supervisor in charge of assembling the trains at the Schwarzkopf GmbH plant.

KOWALKOWSKI, John. Electrician and lead hand employed by B.K. Maintenance Ltd.

MALBEUF, Howard. Mechanical maintenance person employed by B.K. Maintenance Ltd.

MALESZEWSKI, Lester. Mechanical maintenance person and lead hand employed by B.K. Maintenance Ltd.

McCARTHY, Ron. Partner in the firm of landscape architects involved in the early development of Fantasyland.

MILLWARD, Stephen. Chief Inspector of the Elevators and Fixed Conveyances Branch of the Department of Labour.

MOONEY, Michael. Director of Development, Triple Five Corporation Ltd.

MROCHUK, Alan. Electrician employed by B.K. Maintenance Ltd.

PARKIN, Norman. Construction superintendant for PCL Construction Management Inc.

PENN, David. Senior supervisor of the Fantasyland maintenance staff, responsible for day-to-day supervision with respect to the maintenance of all rides and attractions in Fantasyland. Also supervisor of the electrical department of B.K. Maintenance Ltd.

PIPKE, David. Electrician employed by B.K. Maintenance Ltd.

PLUTA, Michael. Second Receiver of Schwarzkopf GmbH, replacing Schaffler.

POTVIN, Elliott. Greaser employed by B.K. Maintenance Ltd.

SCHAFFLER, Alfred. receiver of Schwarzkopf GmbH from June 25, 1985 to January 13, 1986.

SCHLINGMANN, Herb. Millwright employed by B.K. Maintenance Ltd.

SCHULER, Karl. Representative of Schwarzkopf GmbH who came to Edmonton in December, 1985.

SCHWARZKOPF, Anton. Owner of the original Schwarzkopf family company. Consultant to Schwarzkopf GmbH. Developed the concept of the three loop roller coaster.

SMITH, David. Operator on duty at the roller coaster at the time of the accident. Employed by Triple Five Corporation Ltd.

SMITH, Randy. Operated the roller coaster on June 13. Employed by Triple Five Corporation Ltd.

STEEN, Glenn. Mechanical maintenance person employed by B.K. Maintenance Ltd.

STEIN, Karl-Stephan. Production manager at the Schwarzkopf GmbH plant during the manufacture of the roller coaster.

STEINENGER, Mr. Employed by the Werner Stengel firm. Usual contact on behalf of Stengel firm with IMA.

STENGEL, Werner. German professional engineer. His firm did the static calculations for the roller coaster trains.

STORFIELD, Wayne. Manager of the night cleaning crew responsible for Fantasyland, among other areas at West Edmonton Mall. Employed by Triple Five Corporation Ltd.

UPTON, David. Millwright and lead hand employed by B.K. Maintenance Ltd.

VAN DEN BRANDE, John. Millwright employed by B.K. Maintenance Ltd.

VIEBAHN, Wolfgang. Plant manager at Schwarzkopf GmbH during the manufacture of the roller coaster.

ZYLSTRA, Al. Electrician employed by B.K. Maintenance Ltd. On duty at the time of the accident.

Part Two

1. Triple Five Corporation

(a) Senior Executives

Eskandar Ghermezian, President
Michael Mooney, Director of Development
Marion Corsbie, Executive Director, Marketing
William Keur, Mechanical Director
William Canner, General Manager

(b) Operations Department

William Canner, General Manager
Ken Glenn, Operations Manager
(Assistant Managers)
(Park Supervisors)
Shaun Cariou, Area Supervisor (and others)
David Smith) Ride Operator (and others)
Randy Smith)
Dean Jordan)
Cameron Kapty) Ride Attendants
Garry Cunningham) (and others)
Doug Hansen)

(c) B.K. Maintenance Ltd. (Maintenance Division of Triple Five)

William Keur, President
David Penn, Senior Supervisor, Fantasyland Maintenance

(i) Electrical Department, Fantasyland

David Penn, Supervisor
John Kowalkowski, Lead Hand
David Pipke
Al Zylstra
Al Mrochuk
Gerry Theberge
Ulrich Zabel

(ii) Mechanical Department, Fantasyland

Isaac Brower-Berkhoven, Supervisor
David Upton, Lead Hand
Lester Maleszewski, Lead Hand
Herb Schlingmann
Des Fowler
Ken Carr
Howard Malbeuf
Olgierd Straszyuski
Robert Small
Lloyd Rose

Former Employees, Mechanical Department

John van den Brande
Glenn Steen
Elliott Potvin
David Scheer

(iii) Steelworkers Department, Fantasyland

Stuart Houston, Lead Hand
Luc Coderre
Joe Salacki

(iv) Electronic Department

2. **Schwarzkopf GmbH**

Herbert Breidenbach, Owner
Theo Becker, Owner
Wolfgang Carmele, Business Manager
Wolfgang Viebahn, Plant Manager
Karl-Stephan Stein, Production Manager
Mr. Backschmidt, Chief Designer
Mr. Klein, Supervisor, Assembly of Trains
Karl Schuler

Alfred Schaffler, First Receiver
Michael Pluta, Second Receiver

Anton Schwarzkopf, Consultant